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The Welding Engineer

Vol. III. Chicago 608 S. Dearborn St. JUNE, 1918 $2.00 per year in U. S. $2.50 per year abroad No. 6

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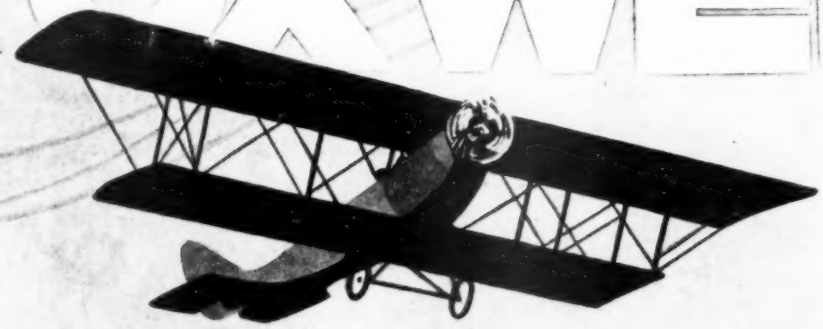

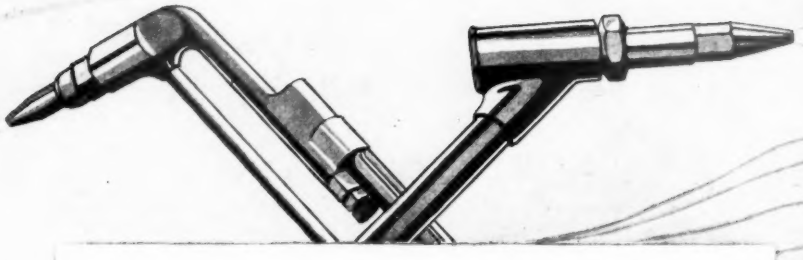

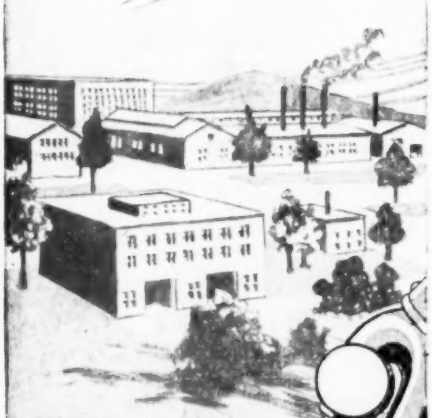

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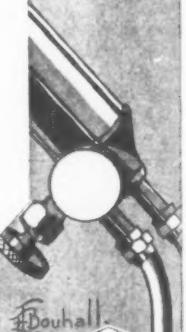

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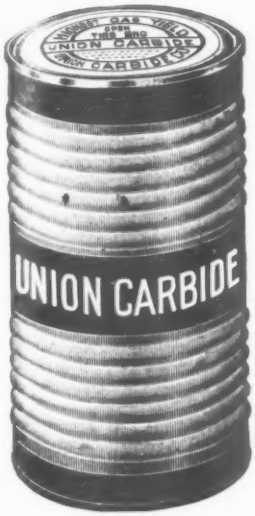

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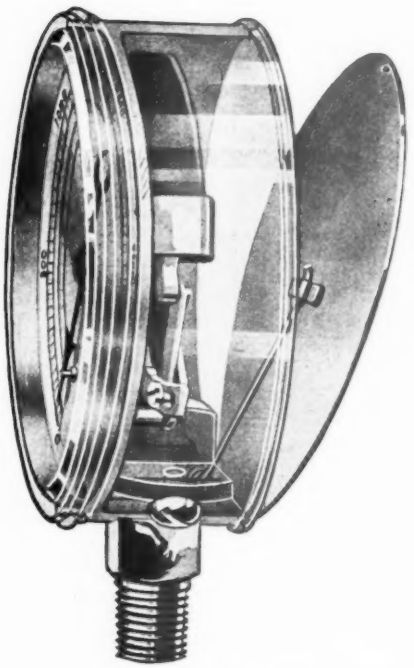

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for

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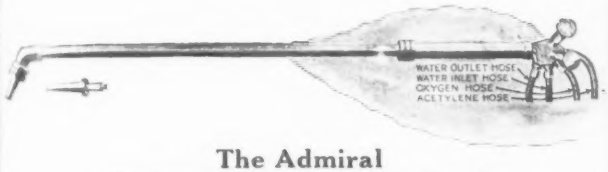

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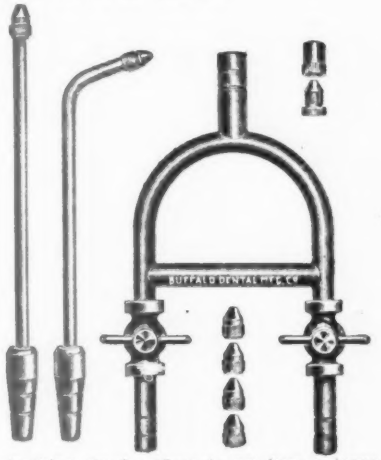

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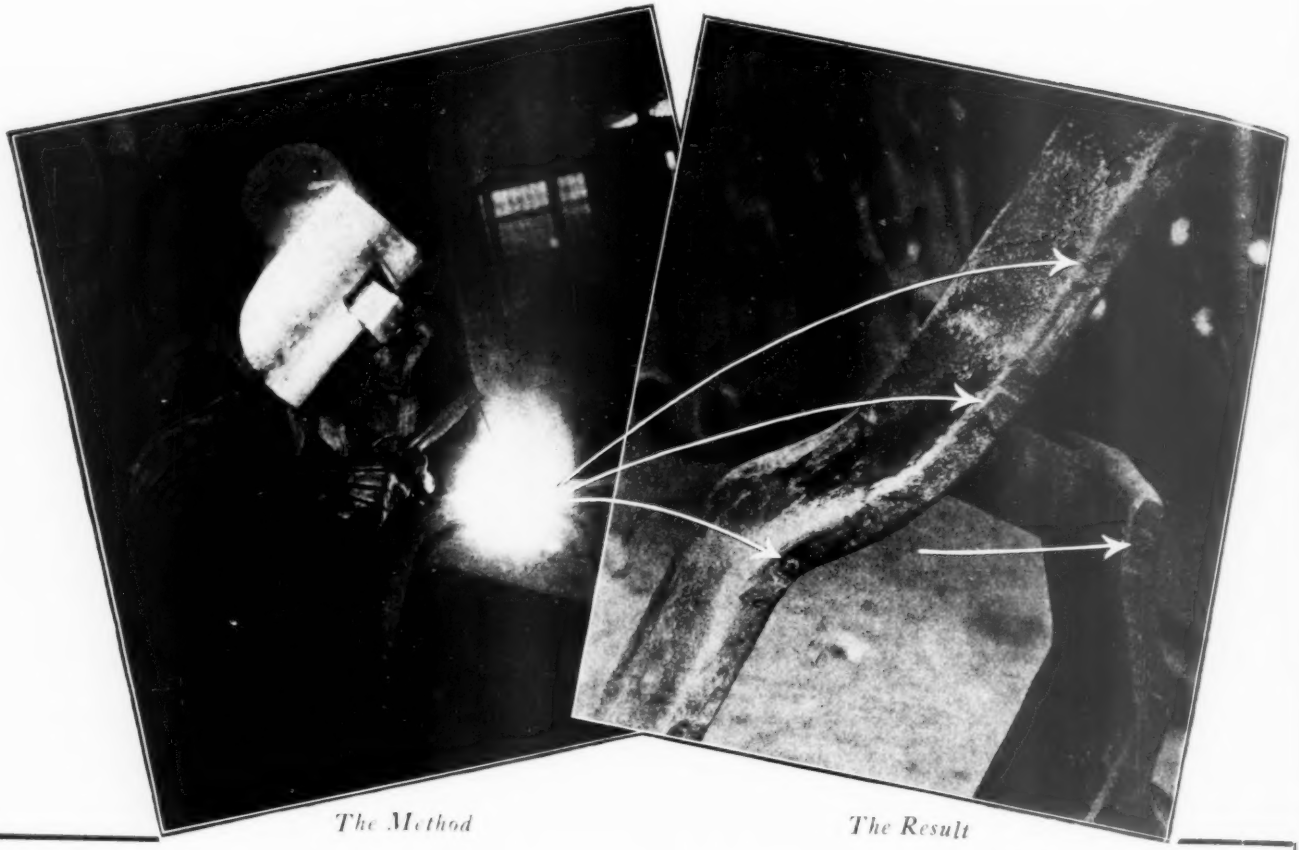

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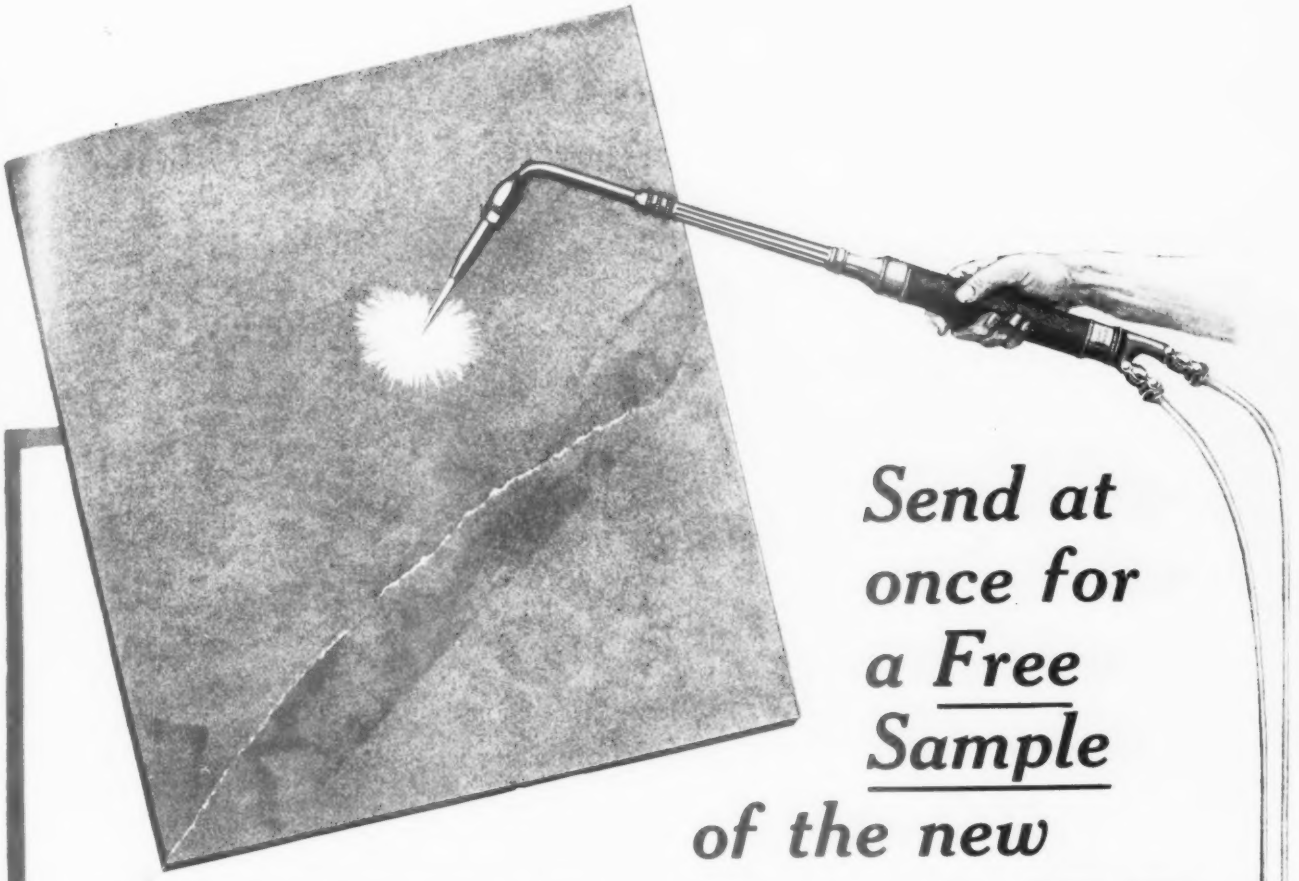

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A Comprehensive Treatise on the Practice of Welding Cast Iron, Malleable Iron, Steel, Copper, Brass, Bronze, and Aluminum by the Oxy-Acetylene Method together with concise information on the Equipment required for both Welding and Cutting by this Process

By S. W. MILLER

287 Pages, 6 x 9 Inches, 192 Illustrations

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Ten years ago the oxy-acetylene method of welding and cutting metals was hardly more than a laboratory process, but in the course of these few years it has become one of the most important of the methods in the metal-working industries. Much has been published relating to this process, but a great deal of that which has been placed on record in the past has been descriptive of odd jobs. It is, therefore, believed that the present volume, dealing in a more systematic manner with the principles and practice of the art of oxy-acetylene welding, will be of considerable value to those engaged in the metal trades.

The information here presented on the subjects of oxy-acetylene welding and cutting has been mainly furnished by S. W. Miller, proprietor of the Rochester Welding Works, whose wide experience in the practical application of the process, and whose success in the work, vouch for the reliability of the information here placed on record. The experience of the author in the oxy-acetylene welding field has been unusually extensive, but having been mostly on repair work, he has written especially for those engaged in a similar line. A great deal of the work done with the oxy-acetylene welding torch is on repairs, and while there are also a great many applications of it in manufacturing work, such applications are more or less special in each case, and sometimes require a great deal of experimenting before success is attained. The general principles here presented, however, apply equally to repair and manufacturing work. This volume describes the equipment required for oxy-acetylene welding and cutting, deals in detail with methods used in welding cast iron, malleable iron, steel, copper, brass, bronze, and aluminum and gives in addition, special attention to the welding of sheet metal, tank welding, boiler repairs, etc., as well as to the subject of lead burning, which is a special kind of autogenous welding.

The book contains twelve chapters headed as follows:

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The time saved in welding the strips together quickly pays for the pincers.

Pressing the spring handle releases the jaws to pick up the metal. Length of pincers, 19 inches. Holds rods of 3-16-inch to ½-inch diameter.

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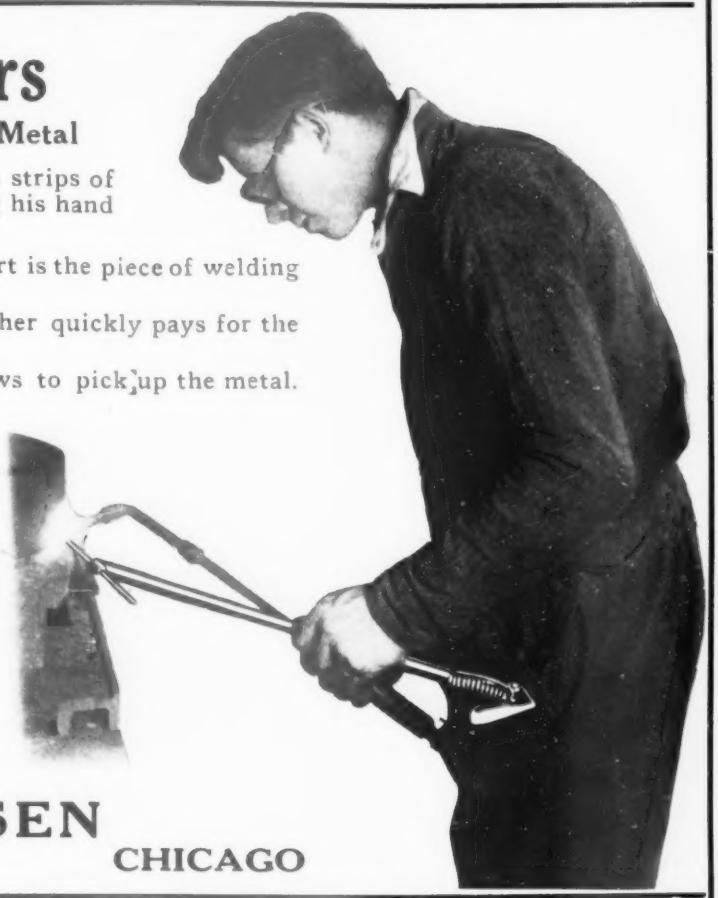

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A better weld will be produced, faster work performed and a decided saving made in the use of oxygen. Every experienced welder will want the equipment because it is technically and practically correct.

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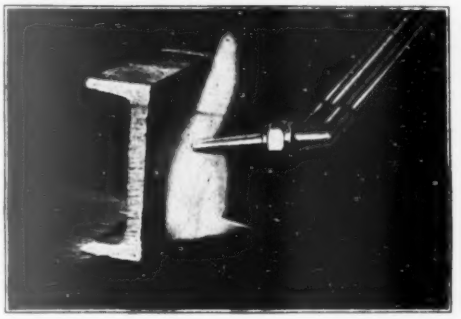
These are **actual** photographs. **You** can make the same tests yourself with the same results.



Welding torch tip directly on metal at white heat. Held there until it penetrates.

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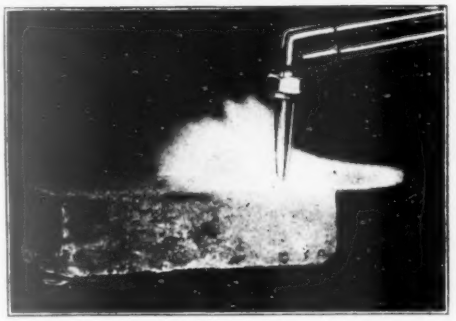
No check valves, cooling devices, porous packing, etc. are employed to prevent the flash. **None of these things even help prevent one.** The flashback in the REGO welding torch is eliminated by removing the **cause**—an excess of oxygen in the mixture.

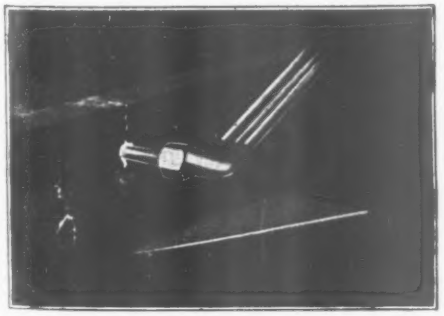


Welding torch tip directly against fire brick. No escape for heat waves except against tip.

NO FLASH

Lower combined pressures are used than with any other torch upon the market. Beware the torch which advertises economy because the acetylene pressure is low—it is necessarily wasteful in oxygen.

Acetylene is the fuel. Oxygen simply helps burn it. **No economy is possible with acetylene,** but huge savings are effected in oxygen and better welds made by the REGO principle of balanced pressures.

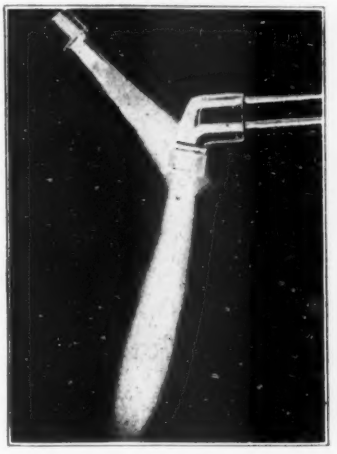


Cutting channel iron with face of tip flat against material.

NO FLASH

Drilling hole through 5-inch axle. Tip in hole. No escape for sparks or heat except against tip.

NO FLASH



Air-gas preheating torch flame playing on mixing chamber of welding torch until tip and nut are at a red heat.

NO FLASH

THE BASTIAN-BLESSING COMPANY

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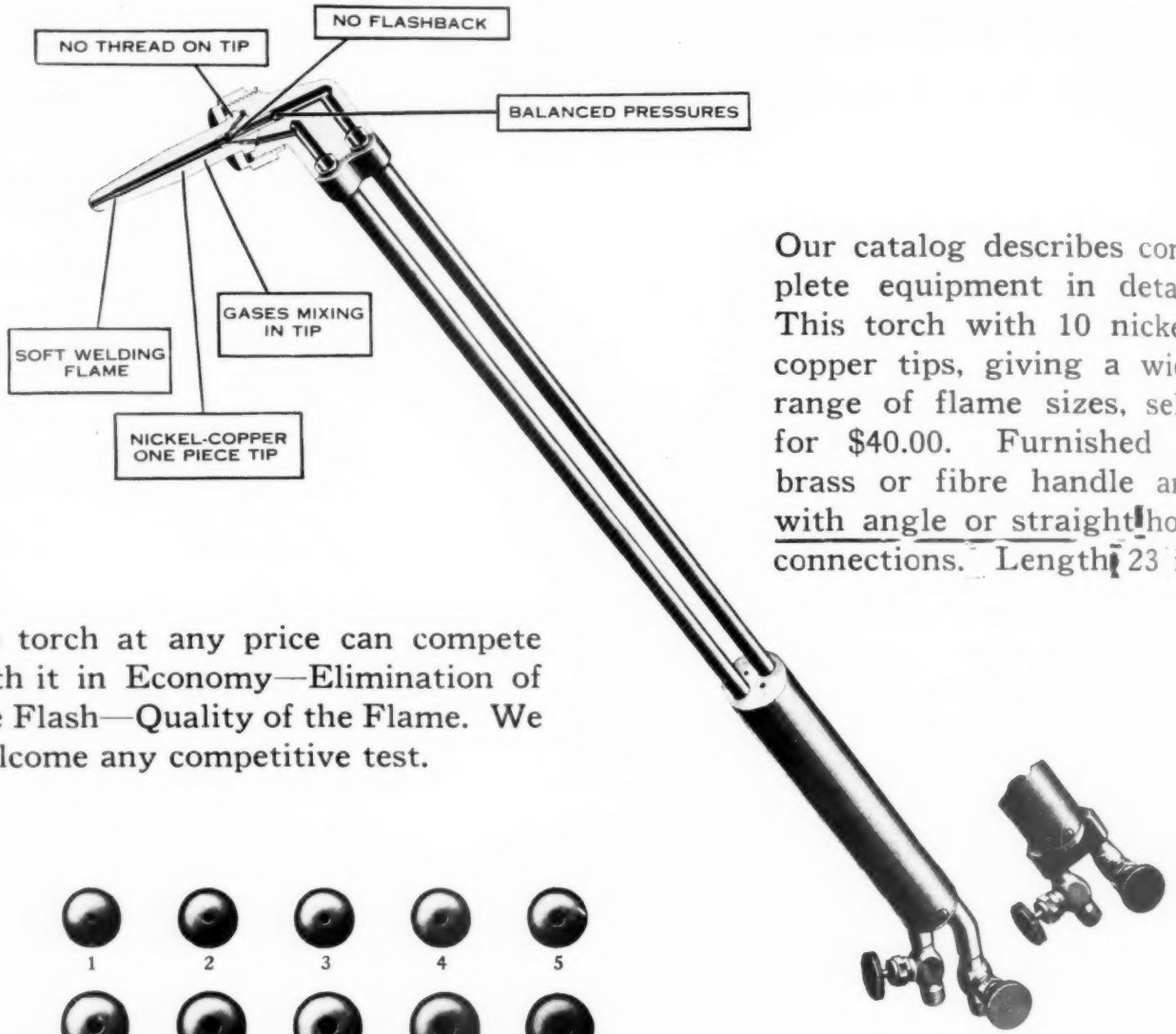
REGO WELDING AND CUTTING APPARATUS



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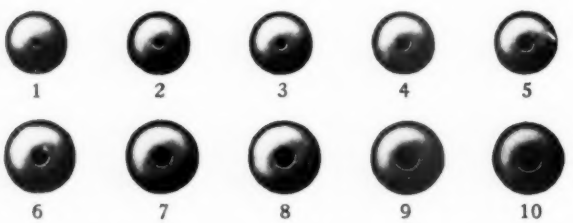
No torch at any price can compete with it in Economy—Elimination of the Flash—Quality of the Flame. We welcome any competitive test.



FACE OF TIPS ACTUAL SIZE

Welders: This torch was **technically** thought out and **practically** built. It's **the** torch you want to do the right kind of work—work which will stand up in laboratory or practical tests. Don't hesitate to order one with the full assurance that your money will be refunded to you in full upon return of the torch to us within 30 days from date of shipment. It isn't even necessary for you to give a reason. If you're not ready to order, ask us for any information you want.

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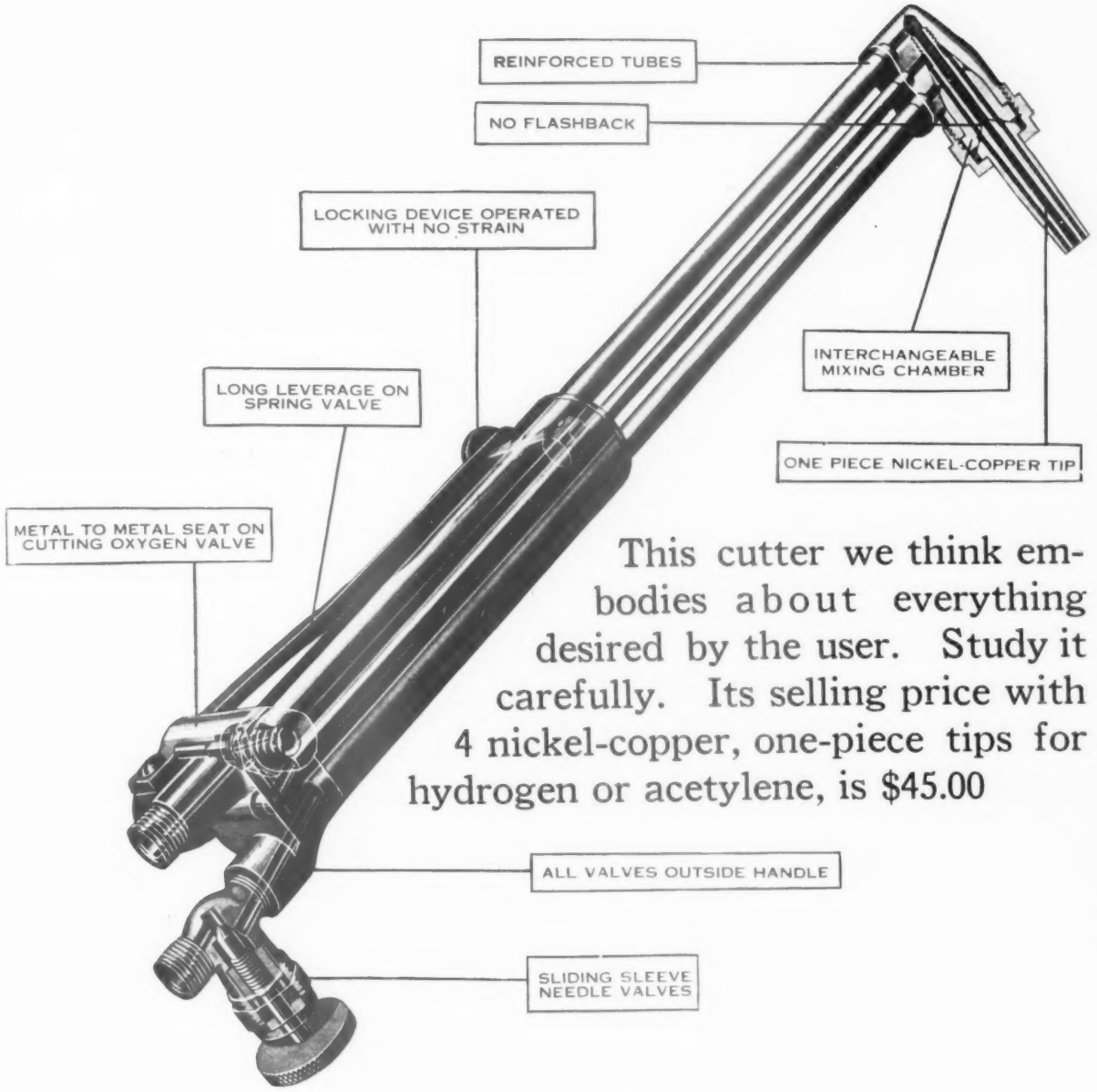
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¶ *Collier's* for March 2nd published a double-page illustration with the title, "An Impossible Plan that Worked."

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P7

The ARMY LECTURE COURSE

Suggested Answers to a Series of Questions Used by the Army Welding School at Peoria, Ill. A discussion of these questions and answers would benefit the industry and readers are invited to send their views to the Editor

Suggested Answers by Mr. S. W. Miller,
Rochester Welding Works

LECTURE NUMBER FOUR

Subject—Welding of Cast Iron

(Part Two)

11. *(a) How could a spoke, broken midway between the hub and rim, of a 24-inch, 4 spoke wheel (otherwise intact) be welded without preheating? (Use a sketch if necessary to make method clear.)*

Answer 11. (a) It would depend on the size of the rim. A heavy rim fly wheel could not be successfully welded without preheating red hot all over.

If it were a pulley with a thin rim, the rim might be sprung out by jacks between the rim and the hub, to get the necessary space between the broken ends of the spoke, to take care of the contraction of the weld.

In the latter case, the writer prefers to preheat the rim on both sides of the broken spoke, as he believes it surer and safer. The amount of heat required is small.

(b) If a wheel of like size were broken only in the rim, midway between spokes, explain procedure in welding without preheating.

Answer (b) A fly wheel would have to be preheated all over. If a pulley, a jack between the spokes might answer the purpose; but preheating the spokes on each side of the break is easier and safer.

(c) Same sized wheel, broken only in hub;—can weld be made without preheating? Give reasons for so thinking.

Answer (c) No. Because provision cannot be made for contraction.

(d) Were breaks (a), (b) and (c) all present in same wheel, with rim facture on opposite side of adjoining spoke from break in hub, should welding be started at rim or hub? Why?

Answer (d) The first thing to do is to cut spoke A to prevent any strain in it, when the hub weld H cools off. Then preheat hub and weld H, and allow it to become cold; preheat at B and R, so that outer end of spoke A moves parallel to itself far enough to get the needed opening at A; weld A and let it cool. Do the same with S. Then preheat at A and S to get opening at R, and weld R. This will work all right for a pulley. For a fly wheel, the process is the same, except that to weld the rim, the whole wheel would have to be preheated.

12. *(a) In the building up of broken or missing teeth in cast iron gears, what procedure is necessary when no carbon blocks are available for forms?*

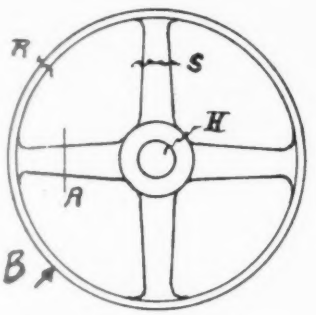
Answer (a) The teeth should be built up, taking care to leave no more metal extending over the faces than necessary. (Building up the rest of the tooth can be done with a smaller tip.)

(b) If certain carbon centers from Dry Cell Batteries are obtainable how should they be treated before allowing molten metal to come in direct contact with them?

Answer (b) See Answer 6 (a-b-c). Lecture 7.

(c) What very important point must be uppermost in mind when Dental work on gears is being done?

Answer (c) There are two things: first, get a solid union between the rim and the added metal by using a large tip, and



Lecture No. 4, Question 11-D.

do this as quickly as possible;* second, do not smooth the sides of the teeth off with the torch, as this will make the faces hard and difficult to finish.

(d) Explain precautions taken in allowing work of this nature to cool.

Answer (d) Covering with asbestos paper is all that is necessary if the second precaution in C is observed.

13. *(a) Realizing that hard spots occur in most welds executed by the new welder and having learned the cause of their presence and how to overcome them, would it not be possible to utilize this process for case-hardening parts which were subject to much wear and little strain? Explain procedure.*

Answer 13. (a) It might be possible in some cases, to heat the part up quickly to a slight depth, and let the colder metal chill it; but dangerous strains would be set up in any complicated piece. The process is, however, not case hardening, but making chilled cast iron.

(b) Why is it necessary to preheat such pieces as the following before the weld is attempted; broken water-jackets on gas engine cylinders, usually brought about by freezing, and holes or cracks in crank cases, caused by loosening of a connection rod; when lugs on the

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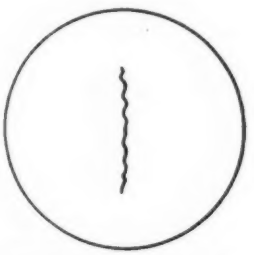
In the April issue of The Welding Engineer, twenty lectures, as used by the Ordnance Corps, U. S. Army, Peoria, were published. The questions only were published, and the object of this article is to give our welder readers an idea of how a skillful welder would answer the questions. These answers have been prepared by Mr. S. W. Miller, of the Rochester Welding Works, Rochester, N. Y., who is, in the opinion of the Editor, one of the leading Welding Engineers of this country. The next installment will appear in the July issue. The questions used are copyrighted by the U. S. Welding Co., Minneapolis, Minn. An article written by Lieut. Campbell, of this school, was published in the March issue.—Mackenzie.

same cylinder, the arms on the same crank case can be welded without preheating, and ofttimes without even dismantling the motor.'

Answer (b) Broken cylinder jackets, and similar parts are what the writer calls restrained welds. Cylinder lugs do not come in the same class, but are unrestrained. The case typical of the restrained weld is a crack in the center of a flat plate, thus:—

If this crack is welded without preheating, the expansion of the metal from the heat first closes the crack, as the colder outside part of the plate restrains it from going any other way. When the weld begins to cool, there is a contraction of the hot metal, which tends to produce the crack in the same place as before. This strain shows up in one, or both, of two ways. If the plate is cast iron, it will crack. If of steel, it will warp. Preheating red-hot will not entirely remove the strain, as the melted metal contracts more than the red hot metal does. So that, while the weld will stand, the plate will be somewhat warped.

The writer recommends all beginners in welding, to drive into their welding consciousness the principle that *in no re-*



Lecture No. 4, Question 13-B.

strained weld is it possible to avoid both strain and distortion.

A cylinder jacket is restrained because it is fastened to the cylinder at intervals, which fastenings prevent the free movement of the jacket. Preheating expands the whole casting, and thus compensates for enough of the contraction to permit the weld to hold; because some strain will not cause cracking: *enough* strain is needed. There are some types of cylinders that are exceedingly hard to weld. For example, the Buick two cylinder block. The jackets are so rigidly fastened to the cylinder barrel, that there is no chance for springing, and a high preheat is necessary. They can always be *welded*, by heating all over red hot; but this causes warping of the bores, and they have to be reground.

What usually happens in cylinder jackets, is that they distort some. If the weld is on a curve, the curve becomes of larger radius—that is, it flattens out, thus relieving the strain.

It should also be said that there are cracks in cylinder jackets that cannot be welded. These are few, it is true. The writer has had probably twenty cases in his experience, out of about 3,000 cylinders. They are usually in places difficult to get at, where it is hard to preheat to the required degree, and where there is no chance for springing—a combination hard to beat.

It is easy to see that a cylinder lug has plenty of chance to spring during cooling, and relieve the strain; and the same is true of a crank case arm. But even in these cases a warming up of the casting is a wise precaution, so that the hot envelope flame will not strike cold surfaces and possibly cause trouble.

LECTURE NUMBER FIVE

Subject—Welding of Cast Iron

(Part Three)

14. *Describe fully the manner in which two cast iron bars measuring one by six inches and twenty-four inches long, are welded end to end, citing preparations, precautions and the procedure and materials necessary to execute and carry the weld through a cool state.*

(Note—Both gases are in the line hoses as far as the welding torch.)

Answer 14.

First:—V the bars on both sides to an included angle of 90°, with hack saw, chisel, or emery wheel.

Second:—Grind or file the faces and edges for about ¼ in. from the Vs, till clean iron shows.

Third:—Put on the table a layer of firebrick, and block the bars up level about 3 inches above the brick, so that a charcoal fire can be built under them. Leave a space about 2 inches wide on each side of the bars, laying bricks so as to keep the fire within this space, and so that it will not be over 6 inches long; that is, the space for the fire will be about 10 inches wide, 6 inches long, and 3 inches deep. The edges of the V should be just together at the side away from the welder and 1/32 inch apart at the side near him.

Fill the space with lighted charcoal, and put some on top of the bars. Put a blower over the fire until the bars are red hot. (A good blower is made from an old carbide can with the bottom cut out. A piece of large stove pipe will answer, and in case of necessity a piece of asbestos paper rolled up and pinned with nails does admirably.)

Fourth:—Clamp or weight at the ends to keep the contraction of the weld from raising the ends. Do not clamp too tight, just solid.

Fifth:—Procure and lay close to the work, but out of range of the flame, cast iron filler rods, and flux.

Sixth:—Put the proper tip in the torch (a No. 8 Davis-Bournonville or No. 12 Oxweld will do the work), set the regulators to the proper pressures, light the acetylene, turn on the oxygen, and adjust the flame to neutral; if everything is all right shut the torch off till ready to weld.

Seventh:—As soon as the bars are bright red, pack asbestos paper around the fire to retain the heat, light the torch and begin to build up at the far end of the V, gradually working toward you, and filling the V up level, as you go along, not letting the metal lap, and floating all the dirt to the surface.

Eighth:—When the first side is finished, turn over, reclamp and finish the other side. Then unclamp and finish the edges. Put the bar in the fire, which should be hot enough to bring it to a good uniform heat, and allow it to cool slowly in the fire. It may be removed when black, and put in a dry warm place till it is cold.

LECTURE NUMBER SIX

Subject—Welding of Cast Iron

(Part Four)

15. (*a*) *Are water jackets on cast-iron cylinder blocks welded in a cold, or a preheated condition?*

(*b*) *Is this true under all conditions?*

(*c*) *If a crack were found in the combustion head of a cylinder block and the entire water jacket and cylinder were cast in one, how should this job be prepared in order to make a successful weld?*

(*d*) *In welding a broken lug on the base of a cylinder block how should lug appear after weld is cold?*

Answer 15. (a) They should be preheated.

(b) Yes.

(c) The jacket should be cut away enough to get at all of the crack in the head. The head can be welded and the piece of the jacket welded back in place.

(d) It should be level with, or a little above, the surface of the cylinder base, so it can be filed level. If it is below the rest of the surface, the chances are that it will be cracked when the cylinder flange bolts are tightened.

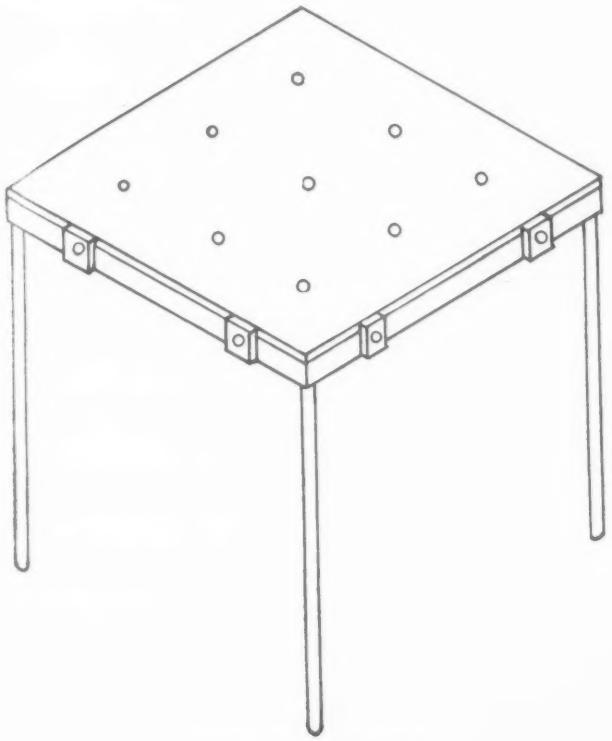
LECTURE NUMBER SEVEN

Subject—Equipment

1. *Describe the operation, step by step, taken to*

up an Oxy-Acetylene Welding plant, from the assembling of the parts, right through, until a neutral welding flame is obtained. (If a sketch, with the gas cylinders and parts numbered 1, 2 3, etc., will assist in making description clear, it may be used.)

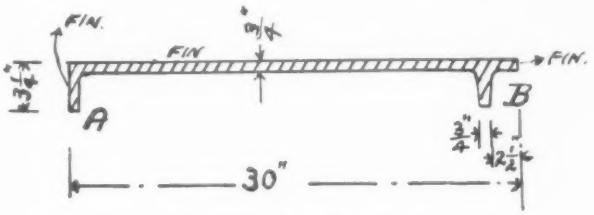
Answer 1. (It is presumed that this question relates to an equipment using a compressed acetylene plant, and not an



Lecture No. 7, Question 3.

acetylene generator.) Blow out all dust and wipe out carefully the unions seats on the tanks and regulators, and attach the regulators so that the handles of the tank valves may be readily opened. Do not tighten the connection nuts and more than enough to make a tight joint. Release the diaphragm springs entirely by loosening the adjusting screws. Attach the hose to the regulators and torch, seeing that the torch handle valves are closed.

Open the tank valves slowly. The oxygen valve sometimes



Lecture No. 7, Question 3.

is hard to start; if it cannot be opened by the hands, use a special wrench about 8 inches long, and do not hammer the handwheel, or use a pipe wrench, as hammering may break the stem, and as a pip wrench is unnecessary. *Open the oxygen valve wide and tight.* The acetylene tank valve usually opens easily. Use the key provided for the purpose, and nothing else. *Open this valve not more than two turns.*

Turn the regulator adjusting screws down till the proper pressures are obtained, as given by the maker of the torch, light the acetylene, turn on the oxygen, and adjust both gases till a neutral flame is obtained.

2. (*a*) *Is it desirable to have a planed metal, or a brick top table for welding purposes?*

Answer 2. (a) Both are desirable. If only one can be obtained, a planed cast iron table should be chosen.

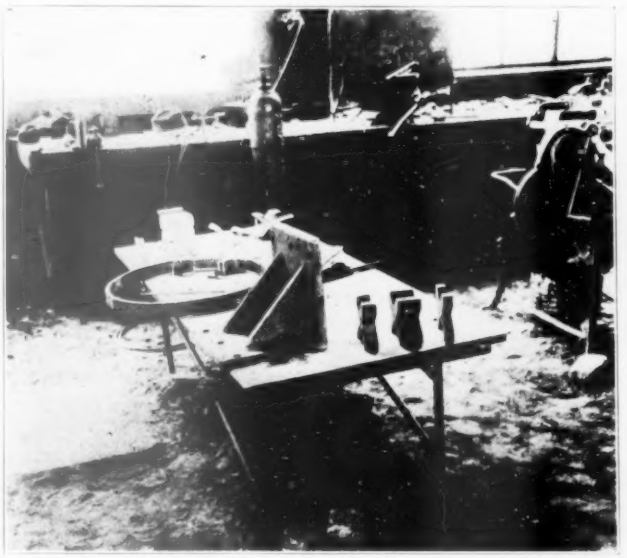
(*b*) *Explain why.*

Answer (b) A brick furnace can be built on the planed table. In fact, for work which has to be lined up accurately, it is often necessary to do so, while a brick top table cannot be well used to line up work.

The writer prefers forges to brick covered tables, as a hotter fire can be maintained, and renewal of bricks is avoided; but brick tables are certainly sometimes convenient.

3. *Outline and describe briefly, a simple method of building a popular type of welding table.*

Answer 3. The author finds a table like the photograph most convenient. It is 30 inches by 6 feet, long enough to line up automobile axles, and for ordinary work from two to four men can work at it. The top and edges are planed, and with two sets of the angle plates and V blocks shown, almost any job of lining or testing can be done. Care should be taken to keep these all in good condition, and not to overheat them. For example, work should never be welded directly on the table, but blocked up off the surface. A cheap table that will answer many purposes is made according to the sketch. The legs and frame may be of 1½ inch angle iron, or 1 inch pipe, and the top, 30 inches square, may be of steel plate or cast iron; if of steel, it should be ½ inch thick, and if of cast iron ¾ inch is better. It may have holes 1 inch diameter in it for clamping pieces down. Small clips, bolted or riveted to



Lecture No. 7, Question 3.

the angle iron, two to each side, and level with the top of the table, will keep the top in place.

4. (*a*) *What is the name and style of bricks used in the welding shop?*

Answer 4. (a) Firebrick.

(*b*) *Name at least three purposes for which these bricks are used.*

Answer (b) Building temporary furnaces for preheating, and for lining forge pans and table tops.

5. (*a*) *Why does an emery wheel ply such an important part in Oxy-Acetylene welding industry?*

Answer 5. (a) Because it is one of the easiest means of making the bevel on small pieces, and because it gives quick results in finishing welds.

(*b*) *Why is it desirable to have a flexible shaft attachment for the emery wheel, if possible?*

Answer (b) Because it can be used on heavy pieces that the stand emery wheel will not handle.

(*c*) *Name some of the important things a flexible shaft*

attachment is used for in the preparation and finishing of welds.

Answer (c) Preparing the Vs and large pieces, and finishing such pieces after welding. One job that can be done very nicely is grinding out the inside of a cylinder after a lug has been welded on.

6. *(a) In what kind of containers is Retort Cement purchased in the commercial world?*

(b) Where is Retort Cement used in the welding shop?

(c) How does it differ from the ordinary clay or putty?

Answer 6. (a, b, c) Nothing is known by the editor of this material. There are several mixtures on the market that are used for preserving holes, as a molding material when filling in, and for some other similar purposes. They are very helpful in many cases. Some of them stick to the metal, and some do not. Each of these types has its advantages and disadvantages. In preserving threads it is bad to have the metal stick, while in building up, it is sometimes desirable that the first metal adhere to the mold, to hold it in place.

A Cleveland concern, the National Carbon Co., make a special line of carbon paste, etc., for welding.

7. *(a) Why should a blacksmith forge be added to the welding shop equipment if one is obtainable?*

Answer 7. (a) Because it is such a convenient means of preheating.

(b) What two important tasks is a forge used for in the welding shop?

Answer (b) Preheating automobile cylinders and crank cases.

8. *(a) It is essential that several pails of water be located throughout the shop; why should this be necessary?*

Answer 8. (a) For fire protection.

(b) Mention a few instances where water is required in the welding shop.

Answer (b) Aside from fire protection, for cooling tips, and testing cylinders and other containers.

9. *Explain fully why great care should be exercised in ventilating a shop where commercial welding is being* done.

Answer 9. Where charcoal is used, the burning of it produces carbon monoxide, a gas which is a real poison, destroying the blood corpuscles. Its effect is noticed first as a headache, and if fresh air is not admitted, it will result in death.

10. *(a) Describe one simple method of constructing a flux box.*

Answer 10. (a) The writer uses shallow tin vessels about 4 by 8 inches and 1 inch deep.

(b) What advantages has this type of container?

Answer (b) They are cheap and do not overturn easily.

LECTURE NUMBER EIGHT

Subject—Repairs

1. *What is the best method of locating a leak in either the oxygen or acetylene lines?*

1. By brushing a thick soap suds on the pipe, especially at the joints.

2. *If a leak were found in a ground seat, how could it be stopped if the nut on the coupling had been screwed up as far as possible?*

2. (The question is not entirely clear; if it means that the threaded end of the nut is too long to allow the ball end of the stem to seat.) The end of the nut can be cut off or a piece of wire coiled around the stem just outside of the collar.

(If the seat or ball joint is cut or rough.) By grinding them together with a small amount of powdered glass and oil, wiping off all traces of oil after the grinding is done.

3. *Name one method of attaching connections to hoses so that they will not blow off or pull off when pressure is applied.*

3. Twist two pieces of wire around the hose tight. Use soft iron wire about 1/16 inch diameter.

4. *How could either an oxygen or acetylene hose that had been burned or otherwise injured, be repaired to withstand the gas pressure?*

4. By splicing it, using a small pipe grooved on the outside and wiring it, as in answer to question 3.

5. *How could regulator be operated if the cross-bar applying pressure upon the diaphragm springs were lost?*

5. (The crossbar undoubtedly means the adjusting screw.) By placing a piece of iron through the adjusting screw hole in the bonnet, against the spring washer, and squeezing it down a C clamp; or even passing a piece of wire around it and the regulator, and twisting the wire till the desired pressure is obtained.

6. *(a) What procedure would be necessary to make connection if cylinders were supplied with an adaptor which would not fit the regulator connection and it could not be coupled up directly?*

(b) Realizing all cylinder connections about a regulator are generally supplied with a ¼-inch taper pipe thread, why do all manufacturers solder them in?

6. (a) If the usual construction existed, the regulator connection and stem could be removed from the regulator body and

Class at Army Welding School at Kenosha, Wis., Established by Lieut. Lorn Campbell, Jr.

the fitting removed from the end of the adapter. The regulator body could then be screwed directly on to the adapter stem, both being ¼ inch pipe threads. In some cases the construction will not allow of this, and the ingenuity of the welder will have to solve the problem. Frequently a welded connection could be made.

(b) The writer presumes that the answer to this would be to ensure a tight joint.

Really if the two threads fitted accurately and had a long enough bearing, say five or six threads, there never would be any leak. Tapers of all kinds must fit, or they are valueless. So that the real answer is, to cover sloppy work, of which the writer has seen many cases in just the place referred to.

7. *Explain why oxygen high pressure gauges are constructed with a loose back and a solid front.*

7. To avoid danger to the welder, if the gauge tube should burst; the flying glass has caused personal injury. The solid front prevents this and the loose back permits of the escape of the pressure.

8. *(a) Where is the first place to seek trouble in a gauge if it leaks?*

(b) Can such leaks be repaired?

(c) Describe method.

8. (a) Probably where the Bourdon tube is soldered into the stem.

Sometimes.

By soldering with a small iron.

If either a high or low pressure gauge were injured beyond the repair state how could welding plant be kept in operation without it?

Remove gauge from regulator, and plug hole with a pipe plug.

10. *(a) What would be the trouble, in shutting off a welding plant, if there were a reading on the high pressure gauge and none on the low pressure gauge, after permitting gas to escape from the hose?*

(b) How could the reading on this gauge be brought back to zero?

10. (a) The hand would have moved on the center spindle.

(b) Remove the hand carefully with a pair of pliers, and replace it with the pointer end just resting on the zero pin when there is no pressure on.

LECTURE NUMBER NINE

Subject—Steel Welding

(Part One)

(*Author's Note*—In this and succeeding lectures, the writer knows that many of the answers that he gives will not be the ones expected. This will especially be the case in matters involving metallurgy, materials used, strength of welds, etc. Many statements that have been made in regard to such matters do not agree with his tests and investigations, and he, therefore, cannot accept them.

It is not his intention, however, to present his views as the last word in such important matters, but simply to give some of the results of his tests and experiments up to the present time. A complete account of them would be needlessly technical for the present purpose, and while some rather obscure matters must be referred to, the endeavor will be made to make them as clear as possible.)

1. *(a) Is the welding of steel more or less difficult than cast iron?*

(b) Explain why.

1. (a) Steel is no more difficult to weld than cast iron, except that a higher temperature must be maintained. This statement is true when ordinary steel plate is the kind welded: high carbon steel is an entirely different matter.

It is also true that a cast iron that is coarse-grained, low in combined carbon, and high in graphite, is more difficult to weld than soft steel plate, or than a fine grained hard cast iron.

(b) It is almost invariably stated that in welding (soft) steel, that is, steel low in carbon (such as ordinary boiler plate, containing from .12 to .18 per cent carbon), the filler rod should be added in small quantities.

This is a serious error. The basic principle of making a weld in *any* metal is *to keep as large a pool of melted metal as possible and put the added metal in as quickly as possible*, due care being given to ensuring thorough fusion of the original and added materials.

The reason for this is obvious. A weld is a casting, and in a foundry the castings are made in just this way. If this method is not followed, laps will result, and dirt will be included in the weld. The same defects exist under bad foundry practice.

2. *(a) Why is the choice of the welding tip so important when working on steel?*

(b) What will result if the tip is too large?

(c) If too small?

2. (a) The size of tip is no more important in welding steel than in welding any other metal.

(b) Too large a tip in any metal will make the control of the melted part difficult.

The usual answer to this is that the steel will be built. The writer does not believe that low carbon steel can be "burnt," as he has never been able to detect any evidences of it in such welds, when properly made with any size tip within reason. It is perfectly possible to make sound welds in ½x2 inch steel with either a No. 6, No. 7, No. 8 or No. 9 Davis-Bournonville tip, but a No. 7 is the best, because it is the easiest.

(c) Too small a tip in any metal results in laps and other mechanical imperfections.

3. *(a) Why is the choice of a "filler-rod" of a correct size so important for steel welding?*

(b) What will happen if the "filler-rod" is too large?

(c) If too small?

3. (a), (b), (c) It is no more important in steel than in any other metal. The writer has used ⅛ inch, 3/16 inch, ¼ inch, and 5/16 inch wire for making welds, using the same sized tip, and had no trouble with any metal. There is a certain amount of waste heat from the flame, which is greater the larger the tip, and the utilizing of this heat can be best done by using a large rod with a large tip. Of course no one would suggest using a ½ inch rod for welding 1/16 inch sheet, or vice versa, but the above is true within all reasonable limits.

4. *(a) What kind of a "filler-rod" is used in welding steel?*

(b) Give the general rule covering relation of "filler-rod" to the metal being welded in all cases, but one or two.

(c) Name one exception.

4. (a) All kinds of material are used, from electric furnace iron to 40 carbon steel; also many alloy steels such as vanadium, nickel, etc.; Swedish iron is also largely employed. Which of them is the best, the writer does not feel called upon to decide. He does believe that different conditions may make it advisable to use different materials. No published tests, that he has seen, give any accurate or reliable comparisons, and the subject needs careful investigation.

(b) The question is not clear. Does it mean the kind or the size? If neither of these, what quality is it desired to compare? If kind or size, these questions have been answered. If some other quality, this will have to be known before an answer can be given.

(c) Cannot be answered without further information.

5. *(a) Is a flux (or scaling powder) necessary in welding steel?*

(b) Explain why.

5. (a) It is not usually considered necessary. But from some of the writer's tests, a proper flux helps by destroying the oxide that is normally in the weld, at least to some extent. The tests are not yet finished. It is a matter worth some study.

(b) The usual answer is that the iron oxide formed by the heat has a lower melting point than the steel has, and, being also lighter, it floats to the top. This is true to a large extent, but it does not cover the oxide included in the weld in microscopic particles, which are sometimes very great in number.

6. *(a) How is the flame adjusted for steel welding?*

(b) What kind of a flame is generally used in finish-steel work?

(c) Why is this done?

6. (a) A neutral flame should be used.

(b) The form of this question indicates that an excess acetylene flame is meant, as an excess oxygen is out of the question. The writer doubts the advisability of using this flame, especially on thin welding, as it carbonizes the steel, making it hard and brittle.

(c) He cannot see the need of it. A properly made weld, using a neutral flame, is free from any but a very thin film of scale (oxide) which is no detriment to the weld that he can see.

7. *(a) How is the flame held when executing a steel weld?*

(b) How is the "filler-rod" held when making a steel weld?

7. (a) This doubtless refers to the usual statement that the tip of the white cone should be just out of contact with the metal. The writer sees no particular objection to the statement, except that he does not believe that any welder ever does it. The conditions of temperature of the metal in a weld vary so much, that a skillful welder advances and retreats his flame al-

most continually. If the metal needs a little more heat, the flame goes closer; if less heat, farther away. Such a motion becomes involuntary after a while.

(b) As in all other metals, the end of the rod should be in the melted pool, but not touching the bottom. This allows the metals to run together, and helps to prevent oxidation.

8. (a) *Is it necessary to "V" out on steel the same as on cast iron?*

(b) *Explain why.*

8. (a) Yes.

(b) For the same reason as with cast iron, that is, so the weld can be begun at the bottom, and built up.

9. (a) *Is a steel weld as strong as the original metal if not built up?*

(b) *Explain why.*

9. (a), (b) It depends on two things:

First—Whether the material in the pieces being welded is as strong as the weld.

Second—What is meant by strength.

If by it is meant the resistance to pull apart or, as it is called, tensile strength, a good weld in soft boiler plate of about 49,000 pounds tensile strength, made with the ordinary welding rod, will always be stronger than the plate, and the break will occur outside of the weld. While if the material being welded has a tensile strength of 60,000 pounds, the break will be in the weld. This is true in machined test pieces, where the section of the weld is the same as the rest of the piece.

If by strength is meant resistance to repeated bending, usually called alternating stress, or if it means resistance to shock, the weld is very much weaker than the original material. When it comes to comparing the physical qualities of any weld with those of a piece of heat treated alloy steel, the former is much weaker in every respect. For example, a chrome-nickel or vanadium steel shaft of proper chemical composition may have, when properly heat treated, a tensile strength of 160,000 pounds per square inch, and an almost uncanny resistance to shock and alternating stress. It is *impossible* for *any* weld, even though heat treated, to approach these results.

The whole point about the tensile strength of a weld, as the writer sees it, is that there is plenty of such strength in any *sound* weld. The trouble is to *produce in all shops mechanically sound welds all the time*. If it were sure that welds in boiler plate would *always* have 50,000 pounds tensile strength, a very notable step in advance would have been made in the art of welding. And, for the present at least, ample *tensile strength* would have been secured.

Of course there are the other physical qualities which should be secured, such as ductility, proper elastic limit, etc. The discussion of all these points would take more time than is allowable here.

10. (a) *Is the same provision made for expansion and contraction on steel as on cast iron?*

(b) *Give reasons for so thinking.*

10. (a) The same allowance *should* be made; but as steel is much stronger and more ductile than cast iron, it can stand internal strains that would be fatal in the case of cast iron.

This is many times advantageous, and makes possible work that could not otherwise be done. For example, if the side sheet of a locomotive boiler firebox were of cast iron, it would be impossible to weld a patch in it, as is done every day with the regular steel sheet construction.

(b) The reason is that no strains should be left in the weld, even though they do not at once cause any trouble—they may later.

LECTURE NUMBER TEN

Subject—Steel Welding

(Part Two)

11. (a) *What is meant by a "Crater" in steel welding?*

(b) *How are they removed from the weld?*

11. (a) A crater is a circular depression in the weld caused by the metal at the bottom of it not being hot enough for the surrounding melted metal to fuse to it. When found they should be removed before adding any more metal, as thye are hard to handle when deep. They are generally formed during the first part of the weld, especially if the V be narrow.

(b) By playing the torch flame around and over them so the heat can soak into the bottom of the crater, and bring it and the surrounding metal to the melting point, when they will run together and the crater disappear.

Metal must not be added during this operation.

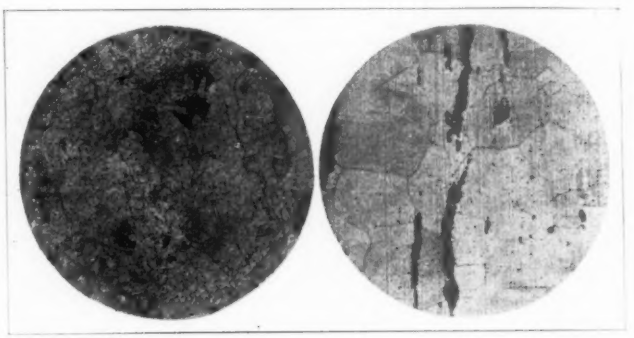
12. (a) *What are some methods and marks of distinguishing steel from other metals?*

(b) *How is cast steel distinguished from cast iron?*

12. (a) The important difference between steel and iron (wrought iron) is that the former is made by the casting process, which necessitates melting; while the latter is not melted, the puddling process being used.

Another difference is that steel usually contains more carbon than iron. But ingot iron contains very little carbon, no more than wrought iron, and is made by the casting process, its production being by the electric furnace.

Wrought iron contains no manganese or sulphur, while steel contains both; but does contain slag, which steel does not. This



Lecture No. 10, Question 12. At left, low carbon steel wire. Note absence of slag. At right, wrought iron wire. Dark spots are slag streaks.

slag can be detected by polishing the surface; if not visible to the naked eye or to a strong hand glass, etching will disclose it. This is done by dipping the polished surface into a solution made by adding to nine parts of water, three parts of sulphuric acid and one part of hydrocloric acid. Pour the acids into the water, and not the water into the acids. An immersion of a few minutes will show the slag streaks in the iron, while the steel will be uniform in appearance.

For quick work, it is only necessary to file the surface smooth with a mill cut file, and then draw file it. For better work polishing with emery paper of increasing fineness may be used.

The surest way is to use the microscope, when even very minute particles of slag may be readily seen.

Steel with high carbon will harden perceptibly, when heated bright red and quenched in water, and the sparks from grinding on an emery wheel are brighter than with lower carbon steel and wrought iron.

There is no sure means of deciding from the appearance between forged or rolled iron and steel of ordinary low carbon content.

Tool steel can be usually detected by its smooth finish, but alloy steels cannot be distinguished from one another. There may be minor differences that to an experienced eye give indications, but to the man not educated in these differences they are invisible.

(b) A steel casting is the proper name for what is frequently called cast steel. The casting is tough, while cast iron is brittle. A small chip from the former will hammer out flat cold, while this is not true of the latter. Cast steel is the English term for

forgings made from crucible cast steel, as opposed to blister steel made by the cementation process, the former being superior to the latter. In this country crucible cast steel is called crucible steel. The writer does not know of any blister steel being made here. Tool and alloy steels are usually made in crucibles, though the electric furnace is being used largely for these grades, and will undoubtedly supersede the crucible.

(These are other instances of the lack of definiteness in the use of the term "steel.")

13. (a) *Name some of the qualifications of a good "filler-rod" for mild steel welding.*

(b) *In what manner does the "filler-rod" differ from the alloyed and high carbon steels?*

13. (a) It should be clean; that is free from slag and oxide. There is no use putting foreign matter into a weld even if it can be floated out.

The proper amounts of the other elements, such as manganese, nickel, vanadium, etc., that are sometimes used, have not, as far as the writer knows, been accurately determined. Of course, phosphorus and sulphur should be as low as possible, but these elements are always low in good steel.

It is sometimes stated that pure iron wire melts more readily than steel wire; this is not so, as any addition of carbon to iron, up to 4.3 per cent, decreases the melting point. Pure iron melts about 2,730° F.; while an iron carbon alloy, with 4.3 per cent carbon melts at about 2,075° F.; so that all steels melt at lower temperature than pure iron.

The writer believes that it is a basic principle in welding that the added material should be of a lower melting point than the piece being welded, other things being equal. The welding of cast iron with steel is not impossible, but difficult, and slow, and the results are liable to be unsatisfactory. This is because of the higher melting point of steel.

Therefore, it is his opinion that the best welding wire for steel, when developed, will have a lower, or at least no higher, melting point than ordinary mild steel.

Inasmuch as a steel weld is nothing but an unannealed steel casting, it is not possible that it can be as good as forged steel; but the closest possible approach should be made to this. This ideal condition will need for its determination a long series of tests which have not yet been made or, at least, not published. One thing should be especially noted; that the qualities of the wire, as far as strength, etc., go, do not determine the same qualities of the weld; the chemical composition of the wire as cast into the weld is the governing feature.

(b) Filler rod usually does not contain more than the normal amount of the usual elements, manganese, sulphur, and phosphorus, and has in it none of the materials used in alloy steels, such as vanadium, nickel, chronium, etc. It is true that welding rods, containing them, are used to some extent, but their value has not been carefully determined, as far as the writer knows. Some of these alloy rods appear to make a more brittle weld than low carbon wire free from them, and welds made with them may be less resistant to shock.

The usual filler rod has very little carbon in it, not over .08 or .10 per cent, while high carbon steel has about 1 per cent or even more. Steel for chisels, lathe tools, drills, etc., is high carbon material.

14. (a) *In bringing the neutral flame in contact with the metal on a steel weld, should the cone bend and spread on the surface, or just lick it?*

(b) *Explain why.*

14. (a), (b) When the maximum of heat is needed, the hottest part of the flame should be placed in contact with the metal. The hottest part is just past the end of the white cone. The cone itself, should not rest on the metal, as combustion in it is not perfect, and there are more or less unconsumed gases in it, which may damage the weld.

15. (a) *What is the principal cause for hard spots in steel welds?*

(b) *What causes some of the others?*

15. (a), (b) If soft steel, such as boiler plate, is referred to, the writer feels safe in saying that there never are any hard spots, if any ordinary welding material is used. Even when drill rod, containing about .9 per cent carbon is used for welding, the weld can be machined, though harder than the soft steel.

In welding high carbon steel, it may be possible to make hard spots by cooling too rapidly; but with slow cooling no trouble will be noticed.

16. (a) *Is it rolled steel or cast steel that does not expand when heated?*

(b) *Name one other metal that does not expand when heated.*

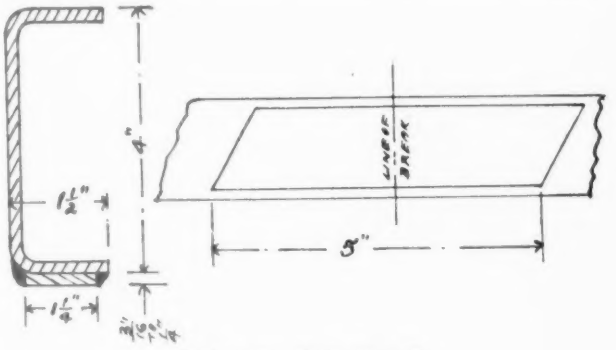
16. (a) Both rolled steel and steel castings expand when heated.

(b) The writer knows of no metal that does not expand when heated, unless the iron-nickel alloy, invar, be referred to.

17. (a) *Why are welds more difficult on sheet iron and steel than on some of the heavier pieces?*

(b) *What can be used as a "filler-rod" on sheet metal work?*

17. (a) The writer does not believe that sheet metal welds are more difficult than heavier welding. A different method of



Lecture No. 10, Question 20.

handling is needed, and if one is not used to sheet metal work it is naturally harder for him to make a good job of it; just as one who is used to only sheet metal work, cannot do good work on heavier welding.

(b) Frequently the edges of the sheet can be bent up a trifle, and in this way the use of separate added metal be avoided. Also the edges of the sheets are sometimes upset, for the same purpose.

18. (a) *What difficulty is generally encountered when making a long weld like on a steel tank?*

(b) *How can this be overcome?*

(c) *Why do the open ends on sheet steel welds overlap in welding when same class of work on cast iron separates?*

18. (a) The contraction of the weld draws the sheets together at the end opposite to where the welding begins.

(b) By separating the sheets at the far end and the proper amount.

(c) This has not been the writer's experience. He finds that cast iron acts the same as steel.

19. (a) *What causes steel welds to carbonize?*

(b) *What usually causes a burnt steel weld?*

19. (a) This can occur if a strong excess acetylene flame be used. Acetylene contains about 92 per cent carbon, and an excess of carbon will unite with the metal and carbonize it.

(b) The meaning of "burnt" should be considered. If the term means what occurs when tool steel is very badly overheated, so that it becomes brittle when both hot and cold, such a condition never exists in ordinary welds (low carbon steel

welded with low carbon material). At least, the writer has never been able to detect any signs of it.

If by "burnt" is meant oxidized, this can be done by an excess oxygen flame, the surplus oxygen combining readily with the hot metal. This oxide appears as a white foam, and unless care be taken, will make laps in the weld, though with care a weld free from laps can be made. It will, however, be full of small specks of oxide, readily seen with the microscope.

20. *Describe fully how a broken automobile frame can be welded and re-inforced to make it stronger than originally.*

20. It depends on where the break occurs; usually it is through the frame and is vertical, or nearly so, the bottom flange giving way first. So the best way is to weld the break first, and then weld a piece of flat steel of somewhat more than the thickness of the flange, and say 6 inches long, across the break, *on the bottom of the bottom flange*, if possible; if not, the next best place is the top of the bottom flange. It is not a good plan to plate the inside or outside of the web as this does not add metal at the point of greatest strain. The sketch shows a good way of applying the patch.

The ends of the patch are cut at an angle to avoid localizing the strain, on the same principle that the so-called "fis htail" reinforcements in bicycle tubes are made. The patch should be welded all around its edge. The dimensions given would have to be varied to suit conditions.

The writer has seen a few frames with lengthwise truss rods, on which the break was on the *top* of the frame, due to the truss rod being pulled up too tight. Such truss rods, as well as those on rear axles, should never be tightened till the weight of the car is on the frame, or axle, and the rods should then be pulled up just enough to take the weight. Many rear axle housings are broken by neglecting this precaution.

LECTURE NUMBER ELEVEN

Subject—Steel Welding

(Part Three)

21 (*a*) *What kind of a "filler-rod" is used in welding cast steel?*

(*b*) *Is a flux used?*

21 (a) Any steel filler rod that is satisfactory for general steel welding.

(b) No.

22. (*a*) *What kind of a "filler-rod" is employed when welding cast iron to steel?*

(*b*) *What kind of a flux is used?*

22 (a) Cast iron.

(b) Cast iron flux.

23. (*a*) *Can springs be successfully welded?*

(*b*) *State reasons.*

23 (a) Not if a job equal to the original is required. Sometimes it is possible to do fairly good work, but it should be only a temporary job.

(b) The reasons depend on the nature of the spring material. In no case can the quality of the weld be the same as that of the original, the former being a casting, not heat-treated, and the latter a heat-treated forging.

24. (*a*) *Why are crank-shaft welds so hard to execute successfully?*

(*b*) *What kind of a "filler-rod" is used for best results on most crank-shafts?*

(*c*) *What point does the welder consider when deciding whether a weld of this nature is advisable?*

24 (a) Because of the difficulty of getting at the weld to ensure its soundness; because the weld is a casting, which has unsuitable physical properties; and because of the difficulty of keeping the parts in line and true.

(b) Nickel steel has been recommended, but ordinary filler rod will give very good results, if properly used.

(c) The writer believes that crank shafts for automobiles should never be welded, as it is not possible to make a first-class job, no matter how good the weld is. If it is insisted on, the welder should clearly disclaim any responsibility except for the soundness of the weld.

Emergency conditions may justify such welding in a special case, and each case should be judged on its merits.

25 (*a*) *Briefly describe the method of building up crank-shaft bearings that have been worn down.*

(*b*) *What are some of the precautions taken in work of this kind?*

25 (a) (b) The metal is added in a thin layer, either parallel to or around the shaft, great care being taken to secure complete fusion. There is nothing special about the work, and any good welder can make a good job, but the shaft will, of course, be overheated, and, therefore, more or less injured.

26. (*a*) *When automobile propeller shafts and rear axles break, it is generally adjoining the square end. Is it advisable to weld this short piece on?*

(*b*) *What is the correct procedure in a case of this kind?*

26 (a) No. The square end cannot be replaced accurately.

(b) Weld on a piece somewhat larger in diameter, and say 6 inches long; this end can be turned down and the square milled, the shaft being thus made true.

27. (*a*) *If a case-hardened ring-gear is to have its teeth built up or new ones added, how is it handled after welding?*

(*b*) *Should all case-hardened work be so treated after welding?*

27 (a) This is also a job that the writer does not believe in doing, because it can never be as good as the gear was, and because of the inevitable warping of the gear. If it is necessary to do it for a temporary repair, the teeth should be filed or machined true, and these teeth only casehardened in the regular way. The use of the excess acetylene flame to carbonize the teeth is not good practice, as it cannot be controlled accurately, and the overheating leads to still further weakening of the metal, and its worse distortion.

(b) Yes. It should be again casehardened.

28. *In welding two pieces of metal, one of which is considerably lighter than the other, how is the flame held in order to bring both pieces to a fusion at the same time?*

28 Direct the flame against the heavier piece more than the lighter one.

29. (*a*) *If a steel weld were to break in the line of weld, how should it be prepared if it is to be rewelded?*

(*b*) *Does this procedure apply only to steel?*

29 (a) (b) In all cases the old weld should be entirely removed. It may not always be necessary, but it is safer.

30. *Were a hole 6 inches square in a sheet of steel to be welded up without preheating, what would be the approximate size of the patch necessary and how would it be prepared, in order to take care of the expansion and contraction strains?*

30 The writer would make it 5⅞ inches square, and bevel it and the sheet all around.

It is not possible to eliminate entirely the contraction strains, but they can be reduced by dishing the patch.

LECTURE NUMBER TWELVE

Subject—Steel Welding

(Part Four)

31. (*a*) *Why should a steel weld of any kind be executed as rapidly as possible?*

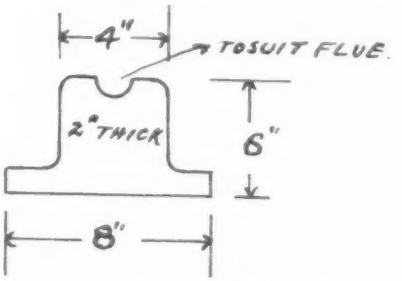
(*b*) *What will happen if steel is kept in a heated condition too long?*

(*c*) *Why should a change be in evidence under these conditions?*

31 (a) All welds should be made as rapidly as possible to save gases and time, and avoid changes in the structure, due

application of the heat, which injures the metal. The grain size increases, and the metal becomes brittle, compared with its original condition.

Just why the grain size should increase is not exknown; nor why such a structure in a piece of steel make it brittle. There are theories which explain



Lecture No. 12, Question 32-B.

many of the observed facts, but they are, in the writer's opinion, too technical to be of value here.

32. *(a) Explain what is meant by a "dished" patch, for boiler or thin armor plate?*

(b) Draw such a patch.

(c) How is a patch of this nature prepared?

32 (a) It is a patch made like a plate or dish, the idea being that on account of its shape, it will give somewhat under the strain and relieve it.

(b) The sketch shows a section of such a patch. The outside dimensions and depth of dish depend on the conditions of each case. The writer prefers a round or elliptical patch to a square one, as the strains are more evenly distributed in both sheet and patch.

(c) By heating the patch red hot, and flanging it over a form to the desired shape. It should be cut to size with the cutting torch after the flanging is done.

33. *(a) What is meant by a "corrugated" patch for boiler or thin armor plate?*

(b) Sketch such a patch.

(c) How is this kind of a patch prepared?

33 (a) The writer has never used such a patch, but supposes a section of it to be like the sketch.

(b) Sketch.

(c) In the same way as a dished patch, the form being made to suit.

34. *(a) What advantages has a "corrugated" patch over one that is "dished"?*

(b) Where are "corrugated" patches used extensively?

34 (a) In case of a long, narrow patch, it might be supposed that there would be less strain than with a dished one, but with an approximately square patch, this advantage would largely disappear, as it cannot be corrugated both ways, because of the expense, which in any case is a serious objection to this kind of patch.

The writer has seen a patch twelve feet long and nine inches wide put in the firebox of a locomotive boiler without trouble, and it was not dished or corrugated; it was slightly curved, however, which allowed for the contraction.

The writer doubts that, for general use, a corrugated patch is of any special value; as a dished or curved patch will answer any purpose, if properly made and applied.

(b) Presumably in locomotive fireboxes, where the cracks are usually localized in quite a small area, and where such a patch might be of some value, in certain cases.

35. *(a) How are boiler flues prepared for re-tiping?*

(b) Sketch a simple jig for holding such pieces in place for welding.

35 (a) All that is needed is to cut the flue and safe-end off square; the use of a pipe cutter or similar tool is not entirely satisfactory; the small bevel so made is rather a help than otherwise, but the projection into the inside of the tube is liable to cause it to be stopped up with cinders and dust.

(b) Three cast iron blocks as shown in sketch, clamped or bolted on a level surface, will answer. Two are to hold the flue and one for the safe end. If this is a regular job, the jig can be made more elaborate for the sake of speed, but will not do any better work. It pays to put two men on this work, one to weld, and the other to handle the flues and safe ends.

36. *(a) Describe how lengths of various sized pipe can be welded together end to end.*

(b) What precautions are necessary when executing such welds?

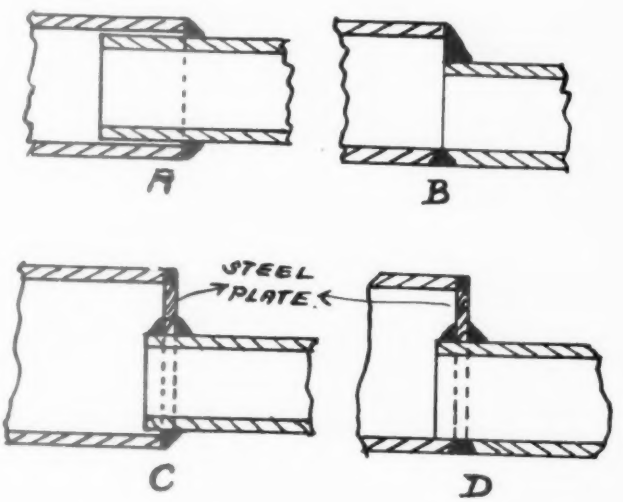
36 (a) If one pipe will just slip into the other one, it may be all right to do it as shown in the sketch A. If it is necessary to drain the pipe (a steam pipe), follow sketch B. If the difference in size is too much for this method, use sketch C or D.

(b) To make sound welds and keep the pipes in line.

37. *(a) When welding large steel castings why is it almost always advisable to preheat the work?*

(b) Why is preheating so necessary on vanadium and other alloyed steels?

37 (a) Aside from the excessive cost of welding gases, there is no torch made with a large enough tip to do the work without preheating.



(b) There is no reason why alloy steels should require preheating more than any other steel.

38. *Why is it desirable to chip out the sand and thin scale formations, in and around blow-holes in steel castings before filling in?*

38 Sand and scale cannot be welded, and interfere with the welding of the metal.

39. *(a) Why do the majority of good welders bend their steel "filler-rods" at right angles about six inches from the end?*

(b) Why isn't this being done on cast iron?

39 (a) It is easier to direct the rod into the weld.

(b) It is frequently done; of course, not by handling the rod, but by welding one rod on the end of another one at the desired angle.

40. *(a) What advantage is there in making a vertical weld from the top down, rather than starting from the bottom and working up?*

(b) In welding overhead why is it so important that the work be in a molten state before adding the "filler-rod"?

(c) In overhead welding, why doesn't the metal drop when in a molten state?

40 (a) None. The advantage is all the other way.

(b) Proper fusion of the metal is necessary in all cases, and is no more important in overhead welding.

(c) Because the surface tension of the melted metal is sufficient to hold quite a good sized drop in place; if the drop is too large, it will fall.

If a needle that is slightly oily be laid carefully on the surface of the water in a dish, it will not sink, but the water will bend a trifle under the needle. This strength of the film of water is called "surface tension" and is the same as the force that makes drops of liquid spherical; in other words, any liquid film has a certain strength.

PACIFIC COAST WELDING SCHOOL

A new welding and steel cutting school has been started at the Oakland Technical High School, Oakland, California. The many shipyards in this district have created a tremendous demand for oxy-acetylene welders and oxy-acetylene, and especially oxy-acetylene cutters. Two evenings each week are devoted to steel cutting and two evenings to welding.

There are twenty-five students in each class, and many are on the waiting list. Preference is given to men of the draft age who expect to work in the shipyards and steel plants. The work has been taken up in a systematic and practical way, with the idea of preparing operators for actual work in the shortest possible time.

The speeding up of the government war work is the main object of the school, and men of practical experience and knowledge have been secured as instructors. A pamphlet explaining the reasons "WHY" is furnished the student for each lesson in advance. This is prepared and explained in a simple manner for the beginner. Then, at the beginning of each class meeting, the pamphlet is studied a very few moments and the work relating to the lesson is taken up. In this manner most of the time is spent in giving the student training in actual work. The lesson pamphlet is retained, of course, for referenec and study.

The interest shown by the students is most gratifying. It is apparent that the importance of this growing industry is widely recognized, and competent men are breaking away from other trades and occupations to take up this work, which appears to have a wider field and a greater future.

The equipment is furnished by the Oakland branch of the Burdett Oxygen Co.

Some of the points discussed and explained in the lesson pamphlets are as follows:

1. Industrial Gases, Cyl. Pressures, Properties, etc., of
   (a) Oxygen.
   (b) Hydrogen.
   (c) Acetylene.
2. Chemistry of Welding and Cutting Metals—
   (a) What change actually takes place?
   (b) Why is it impossible to cut some metals?
   (c) Why does the oxy-hydrogen flame leave a cleaner edge than the oxy-acetylene flame?
   (d) Why does the oxy-acetylene flame carbonize the edges of the metal?
3. Getting Ready for Work—
   (a) Rules necessary to remember to start work.
4. Practical Cutting and Welding—
   (a) Discussion of ordinary cutting work.
   (b) Discussion of ordinary application of welding.
5. Necessary Precautions—
   (a) Care of equipment.
   (b) Action to take in emergencies.
6. Importance o fRegulators—
   (a) Principle of Operation.
7. Points to Remember—
   (a) Reliable and unreliable equipment.
   (b) Difference between pure oxygen and that now being made and sold by air-reduction processes.
8. Preparations for Welding—
   (a) Adjustment of flame.
9. Preparation of Mild Steel—
   (a) Position of torch.
   (b) Beginnnig the weld.

Welding Class, Oakland Technical High School.

10. Sheet Metal Welding.

In order to save time, questions are written out and handed to the instructor by the students from time to time. Then at certain intervals these questions are read to the class and answered. This saves much time and also repetition of many questions.

Mr. W. B. Perdue, of the well known Judson Mfg. Co. of Oakland, Cal., and Mr. Lamberson, of the Chevrolet Motor Co. of California, have been appointed directors of the classes, each taking two evenings per week.

"WELD' THE ALLIES TOGETHER AND 'CUT' OFF THE KAISER" is the slogan of this welding and steel cutting school.

THE ARMY LECTURE COURSE

Comments on Answers

By M. Keith Dunham, Engineer
The Bastian-Blessing Company

Lecture No. 1

Question 4 (b). How much pressure should be placed on the acetylene hose, when the torch-valves are closed, before starting to operate with a medium sized tip?

Answer 4 (b). Whatever the manufacturer calls for. In case of a Davis-Bournonville No. 5 tip, 5 pounds. The Oxweld torch acetylene pressure is very low, and their regulators are not provided with low pressure gauges; in such a case, turn the regulator adjusting screw down till a current of gas can be felt against the cheek with the torch handle valve open.

(Note.—One familiar with torch design can usually guess rather closely as to pressures, but so much depends on the sizes and arrangement of the passages, that care should be taken to get instruction from the maker, who will be glad to furnish them.)

It is well to state here that in torches of the Davis-Bournonville type, the oxygen should be shut off first when turning the torch out; and the oxygen should be shut off last in turning off torches of the Oxweld type. This will avoid flashing back.

Comment.—Mr. Miller's answer applies to the pressure chart of the manufacture and with the assumption that the gauges are correct. As a matter of fact the torch pressure on the gauge with the valves on the torch closed would be higher than with the torch valves open, so that if the manufacturer's pressure chart calls for 5 pounds pressure the gauge pressure would be 6 or 7 pounds, depending upon the condition of the regulator seat. The proper way to operate an injector principle torch is to turn on the oxygen and light the mixed gases. Of course this rule is not always followed by the operator. If he is using an injector torch on dissolved acetylene he, as a rule, operates that torch the same as a pressure torch.

I cannot understand Mr. Miller's advice to turn off oxygen first in medium pressure type torches and last in injector torches. Operating with dissolved acetylene it should make no difference which gas is shut off last. With any type of torch, if the acetylene valve is closed first there is a decided oxidizing mixture within the interior of the tip which is likely to flash, but this flash can be avoided by closing the valve quickly.

It seems to me that the question could be answered in a general way by stating that a medium sized tip could be operated with 6 or 7 pounds pressure on the acetylene hose.

Question 10 (b). Why should particular care be taken to see that acetylene cylinders are tightly closed when empty?

Answer 10 (b). Because acetylene mixed with air in the right proportions is explosive.

Comment.—Mr. Miller has evidently misunderstood this question because it explicitly states that the tank is empty of acetylene, whereas Mr. Miller's reply says that acetylene mixed with air is explosive.

The proper answer should be that the solvent in the cylinder is a volatile liquid and if the tank valve is left open this solvent is likely to vaporize and create an explosive mixture.

Lecture No. 2

Question (4). How is the torch and the welding treated after repeated "flash-backs" have taken place?

Answer (4). (The question is not clear.) Flash-backs result from various causes, and, of course, the cause should be removed. If after a number of flash-backs, the flame appears weak, probably some of the small passages are plugged up with soot, and should be cleaned out. If the tip is hot, it should be cooled off.

No effect of flash-backs on the welding (if this means the work being done) is known to the writer, except that a crater may be formed. If this is what is meant, the metal around the crater must be heated up till it and the bottom of the crater are hot enough to unite.

Comment.—From the welder's standpoint, this question could be answered by saying that particular care should be taken to see that the flame is neutral, by thoroughly cleaning out the torch and by having the mixing chamber and tip cool. The work naturally cools down during this period. Perhaps this is what is meant by treating the material after repeated flash-backs have taken place.

Another effect of the flash-back on steel is to deposit in the weld considerable carbon. As is well known sparks and soot (carbon) are emitted from the torch tip during a flash-back and unless the torch is withdrawn from the heated area very quickly some carbon necessarily is deposited in the steel. The cause of the flash-back is something which cannot be removed by the welder. It must be done by the manufacturer. It may be stated that the one and only cause of a flash-back is that the mixed gases are not moving at a speed greater than the backward flame propagation of the mixture. Nothing else can cause a flash.

Question (6). Explain the difference between high and low pressure regulators.

Answer (6). This question is also not clear. Is the pressure referred to the tank pressure, or the reduced pressure? In any case, there is no need for any difference, except that an oxygen regulator should not be made of any brittle material, like cast iron, nor contain any iron or steel, as corrosion must be avoided. An acetylene regulator may be made of cast iron.

Comment.—This question can be answered by stating that the difference between high and low pressure regulators is the delivery pressure. The low pressure is used for welding; the high pressure for cutting. Some welders use a cutting regulator on a welding torch, but due to the fact that it is impossible to manufacture a regulator which will deliver at high pressures and at the same time have it very sensitive, the high pressure regulator should not be used except in emergencies for welding.

Question 8 (a). Why should all tension upon diaphragm springs be removed before admitting gas under pressure to the regulator?

Answer 8 (a). To prevent a sudden opening of the tank valve admitting enough pressure to overstrain the diaphragm, and cause it to buckle.

Question 8 (b). Can a regulator which has been abused in this manner be repaired?

Answer 8 (b). Yes. By renewing the diaphragm.

Question 8 (c). What can be employed as a fitting substitute for Gallalith?

Answer 8 (c). Nothing the writer knows of is as good. The material mentioned is nothing but horse hoof. It cannot now be obtained. Hard rubber and fibre are used instead.

Comment (a). Tension upon regulator springs should be removed before the gas is turned on from the cylinder, as the sudden entrance of the gas into the body of the regulator throws the seat against the nozzle with terrific violence, which may result in cracking or destroying the seat. As a rule it will not hurt the diaphragm.

Comment (b). Yes. A regulator abused in this manner can

be repaired by renewing the seat.

Comment (c). Fibre may be used as a substitute for Gallalith. Under no conditions should hard rubber be used, as this is too inflammable and there is a hazard in its use which might result in spontaneous combustion. Gallalith is not horse hoof but is a hydraulically pressed product made from casein and formaldehyde. Casein may be better known as sour milk. Casenite, which is practically identical with Gallalith, may be obtained and is at present used by many of the large manufacturers. The supply in this country is practically unlimited.

Question (9). Explain why the high pressure gauge on the acetylene regulator cannot be used as an index to the contents of the attached cylinder of gas in exactly the same manner as the oxygen high pressure gauge.

Answer (9). Because of the conditions mentioned in the answer to question 2-B; that is, because a slight change in temperature makes a great difference in the gauge reading.

Comment.—The high pressure gauge on the acetylene regulator cannot be used as an index to the contents of the cylinder because the acetylene is dissolved in the solvent, and upon the purity of that solvent and the amount in the cylinder depends the cubical capacity.

"THE ACETYLENE GAS SITUATION IN AMERICA"

By Lieutenant Lorn Campbell, Jr., Ord. R. C., Ordnance Welding School, Peoria, Ill.

In the oxy-acetylene industry throughout America, the manufacture of the oxygen gas and the free loan system of the cylinders has been rapidly increased with the growth of the marvelous industry and at the present time there is no preceptable shortage of this gas. Even the small individual oxygen generating units have felt this increase and have ceased to generate their own oxygen because purer gas, at a lower price, with excellent service can now be obtained from any of the large manufacturers of this gas.

The acetylene gas situation, however, presents a very different phase. While there has been two sources of supply open to the trade, i. e., tank gas (dissolved acetylene) and generator gas, the former has always been the more popular; undoubtedly on account of its purity and portability, although the gas generated on the job from calcium carbide costs only half as much as the other and the welder may have a never ending supply of gas on hand at all times. For the past year acetylene cylinders have become very scarce and many welding shops throughout the country have been embarrassed frequently because of a shortage of acetylene. Reasons for this shortage are quite evident. While oxygen is produced by air reduction, electrolitic and chemical processes and compressed in one-piece, steel-drawn cylinders at a pressure of eighteen hundred pounds and the gas may be withdrawn at a very rapid rate without any harm to the cylinder as there is no filler or absorbant packing present to escape; the acetylene cylinder, unlike that of the oxygen, must be packed with a filler and an absorbant which will dissolve the gas and prevent any portion of it being left in a free state when under pressure, as such a condition would make it dangerous to handle. This absorbant is acetone, which is capable of absorbing twenty-five times its own volume of acetylene gas at normal temperature. This acetone is very expensive which makes the cost of manufacture for the acetylene cylinder much greater than the oxygen. Then, too, the cost of maintainance of the former is great because if the gas is withdrawn too fast it carries some of the acetone with it, while in the case of the oxygen there is no such cost.

The oxy-acetylene industry has shown such growth in the past year that it would have been very difficult for the manufacturers of tank gas to keep pace with it, under normal conditions, but when one considers that one of the largest institutions in the world, the United States Army has recently taken up welding and is using the tank system on its thousands of repair trucks overseas, all of these cylinders being withdrawn from the commercial world, it can readily be appreciated why a tank shortage is in evidence in this country.

The rapid turn over or exchange, of the cylinders is another condition which may well be considered. With freight moving at its best there was not much to hinder the quick transportation of these cylinders, but with the comparatively recent embargoes there has been more delay in shipping than usual.

The acetone, too, has a direct bearing on the case. Its use in the manufacture of smokeless powder is such that the government has commandeered practically the entire production, which makes the original charging of the acetylene cylinders and their upkeep a very difficult problem.

The question in every American citizen's mind today is: How to assist the government to the best advantage. The oxy-acetylene welder must surely realize that the government needs acetone; that the cylinders for acetylene are required overseas and that the railroads have only limited space in which to care for the commercial world. Where, then, should he not turn to the acetylene generator? It does not use acetone; the carbide shipments are much smaller than the cylinders, and there is no return; and then, too, the generated gas only costs about one-half the amount of the tank gas.

It is true that at one time acetylene generators were cumbersome things and there were feed mechanisms which made the pressure vary from time to time, but great improvements have been recently made along these lines and it is now possible to obtain an exceedingly simple, practically fool-proof acetylene generator with a positive pressure control that will produce a clean gas from either a portable or a stationary apparatus for a very reasonable price, from any first-class welding company, and it behooves every welder to consider this question well, in order that he may have a good supply of acteylene gas on hand at all times and continue to maintain America's machinery and reduce the nation's scrap pile with his welding torch.

USE OF OXY-ACETYLENE WELDING BY THE FRENCH ARMIES

Oxy-acetylene welding is used extensively by the French armies for both manufacturing and repair work. Its use in manufacturing is practically the same as it is in the United States. In repair work it is used at posts situated out of range of shell fire, as it has been found that the men cannot do efficient work when exposed to fire. It is also used at all base shops at Paris and other cities. Wherever possible, damaged parts are replaced by new ones, otherwise the work is moved to a repair camp in the rear. At the repair camp the work is usually carried on in a small hut about 12 feet square, although in some cases it is done in the main repair sheds. Acetylene is usually generated at the repair huts, and is used in cylinders only when necessity demands it. Portable generators are employed for large work which cannot be handled inside the hut. Oxygen is obtained in cylinders holding from 6 to 7 cubic meters. The use of the process by the French armies has two limitations: First, lack of capable welders, and, second, limited supply of oxygen cylinders. With the first call to the colors the men experienced in welding were sent to the trenches but later recalled to industrial work, especially in the manufacture of bombs used in trench warfare, aeroplanes, etc. As a consequence very few men can be spared for repair work at the front and there is a consequent loss, wastage and burden on transportation which could otherwise be avoided.

Organization

Each army has its own corps of engineers, autos, artillery, railroads, airplanes and each one of these divisions looks after its own repair work. As far as oxy-acetylene is concerned they work independently of each other.

Apparatus

The apparatus used in the army is practically the same as that used in industrial work. The number of apparatus needed depends on: Number of heavy guns, light guns, motor cars, miles of track, airplanes, bridges, amount of piping, activity of the army, etc.

Fields of Utility

The oxy-acetylene process is used in the following branches: Aeroplanes (including lorries), artillery, automobiles (autos trucks), engineers and railroad work.

Aeroplanes

One welding set and two expert men are used for each 150 autos. This is independent of welding apparatus used for motor lorries. The French do not repair cracked motors at the front as they feel that so much depends upon the motor that they can not afford to run any chances.

Artillery

One set of apparatus and two expert welders for each 100 guns of 105 mm. to 280 mm. caliber. Somewhat less for smaller calibers. This will also take care of trench guns and morters. The welding is mostly done on gun carriages, accessories, gun feet, etc., rather than on gun barrels themselves. When badly damaged the artillery is sent to the repair camp and new guns are daily sent forward, and the old or damaged parts returned to the park, as the artillery camp is called. The park is equipped with lathes, forges, etc., so that rather extensive repairs can be made, and when guns are too badly damaged the undamaged parts are used in forming new ones. Two experienced men are used for each welding set as well as two or three helpers—inexperienced soldiers or even German prisoners being employed

Automobile Service

Autos are subject to damage by ordinary wear and tear, accidents and shell fire. Autos breaking down on route are repaired where possible by replacement of old parts by new ones, broken parts being returned to parks or else thrown away. There are about 50 such parks in France taking care of 1,000 to 2,000 cars each. Outside repairs to cylinders are executed at parks, but inside repairs in Paris where suitable boring tools are to be found. At one reserve park situated about thirty miles from the front they employed three sets of apparatus and four men and used 1½ bottles or 10 cubic meters of oxygen per diem. This park served 3,000 automobiles. One set of apparatus and two men needed for each 400 to 500 autos, including trucks and passenger autos.

Engineers

The departments of the engineers are: Department of bridges, electricity, search lights, engineers' park for waterworks, etc.

Department of Bridges

One set of apparatus and two welders are furnished to each army corps. Dissolved acetylene is used on account of its transportability. The process is used for cutting broken bridges and repairing ponton boats and as the men have to work under fire in their cutting work, it is necessary to have additional trained men to take the place of those wounded or killed. As the work provided is extremely irregular the welders can be employed on other work during quiet periods.

Department of Electricity

The department of electricity employes oxy-acetylene welding mostly in connection with cracked frames of gasoline motors used to drive dynamos for generating electricity used at and near the front. On account of shell fire it is found impracticable to bring electric current from generating stations situated well to the rear and therefore gasoline motor generating sets are employed locally. Two men and one set of apparatus take care of all the work necessary for an entire army of 200,000 or more men.

The last two departments do not employ oxy-acetylene welding.

Railroad Work

Narrow gauge railroads, about two feet (60 cm.), are extensively used in handling guns, ammunition supplies and all kinds of material from the terminals of the broad gauge railroads to the front, such narrow gauge track often going to within 400 yards of the front trenches. The locomotives used are of two kinds, steam of the Baldwin type and gasoline motors, the former being used farther to the rear while the gasoline motors are used near the front where they are operated at night. The cars are usually of steel and hang very low. This equipment is broken and damaged through actual hard wear and frequently also by shell fire. It is thus that the oxy-acetylene process is used not only for welding broken parts but also for cutting away parts badly damaged by shell fire. At the repair yards two sets of apparatus, one stationary and the other portable, are provided so that large pieces such as cars, etc., which cannot be brought into the welding but, can be repaired in the open. The process is of great value in this work as a locomotive, either steam or gasoline, may be so badly damaged by shell fire as to make replacement of the parts impossible but can be repaired by welding. Thus, one motor locomotive inspected had a cracked frame, a broken oil inlet pipe, and a broken cross member involving the welding of steel, brass and aluminum. This work was easily repaired whereas otherwise it would have involved either the scrapping of the locomotive or the shipping of the whole machine to a main repair shop located perhaps 100 miles to the rear. The repairs were actually made within six miles of the front.

On a front of about 60 miles there are three posts of repair yards for this class of work, serving about 250 locomotives in all. Each post has two sets of apparatus and three experienced men. About 100 cubic meters of oxygen are used monthly at each post.

These figures are given for a front which is extremely inactive at the present time and even now a much larger use could be made of the process were equipment and men available. One set of welding apparatus and two men should be provided for from 40 to 50 locomotives and their cars or trucks.

Forts

Oxy-acetylene welding has been found available in connection with repair work at forts, such as those surrounding Verdun. Broken cupolas, etc., can be repair and debris cleared away by this process. At present one set of apparatus with two welders using six cylinders of oxygen and six cylinders of acetylene per month are employed to take care of all the forts around Verdun. A larger equipment than this would be desirable but cannot be supplied at present owing to the lack of organization.

In order that the United States army in France may have an adequate supply of welders, the engineers have opened a school of oxy-acetylene welding and cutting at Washington Barracks, D. C. This forms a part of the military trade schools located at that post. Enlisted men from the First Replacement Regiment of Engineers are sent to this school to learn the manipulation of the welding torch and the application of the process to military needs. Even the expert welder must learn how to adapt himself to the rough and ready field conditions.

This course forms the last part of a three months' training period and, upon leaving the school, the soldier is sent to the engineer unit which can most efficiently use his ability. Full information as to this school and the work of the engineers may be obtained from the Publicity Office, First Replacement Regiment of Engineers, Washington Barracks, D. C.

WELDING SCHOOL AT THE CARNEGIE INSTITUTE OF TECHNOLOGY

By S. E. Dibble.

At the beginning of the preparations of the United States for war, the Carnegie Institute of Technology turned over its laboratories and shops to the work of the government for the trade training of enlisted men.

This has brought about a remarkable change in the shop devoted to oxy-acetylene welding. Originally consisting of but a single torch, the equipment has been gradually increased, as necessity demanded until at present 20 flames are actively spitting and sputtering all day.

The increased number of flames necessitated larger benches and consequently greater floor space. These have been provided, furnishing accommodations for the instruction of 160 men in autogenous welding.

The welding shop occupies three rooms, a lecture room and two shops, one above the other. The second floor shop is used for light welding. It is 70 feet long, 55 feet wide and about 30 feet high. The room is well lighted with windows on three sides, running full height. There is a large exhaust fan to care for the proper ventilation of the room. In this shop are 12 iron top benches 5 feet square with a vise clamped on each side. Under each vise is a tool box containing hammers, files, chisels, etc. This room is also equipped with four iron top benches, 42 inches wide and 12 feet long.

In the center of the room is a long cement top table with working accommodations for six welders. This table is of heavy construction and with its cement top makes an ideal welding table. Under the top slab of cement an acetylene pipe runs around the table with three outlets on each side. The six flames are arranged so that the welders do not stand opposite each other, but are staggered along the sides.

The first floor shop is used for heavy welding. The room is the same sized as the one above and its light and ventilation are ideal for the work in hand. It is equipped with two iron top benches, 42 inches by 12 feet, for preparing or finishing work, and also with three cement top benches 3 feet by 18 feet each, of which provides working space for five welders. For preheating there are supplied four low tables especially designed for the purpose.

The lecture room which adjoins the second floor shop has a seating capacity of thirty. It is well lighted and furnished with blackboards for illustrated talks. There are books on welding for class study and the technical library near by furnishes material for study outside the shop and lecture room.

Oxy-acetylene welding is a rather difficult trade for the ordinary school to attempt to give instruction in. The nature of the work being such that, unless material actually in need of the welder's torch is supplied for instruction purposes, little practical value results. But the Carnegie Institute of Technology has no such difficulty, for practice material is constantly being provided for the welding classes from its own foundry, auto-mechanics laboratory, and machine shop.

Instruction in welding is divided into the following hours:

Lectures	26 hours
Quiz	10 hours
Shop work	260 hours
Inspection trips	16 hours

The lectures cover the entire welding field and mimeograph sheets containing notes on the lectures are given out for study. In connection with the institute is a large technical library. Use is made of this library by the students in looking up subjects that are assigned and require outside study.

One of the first jobs given is the welding together of pieces of angle iron and then testing the welds. Every man must weld these pieces and then test his own welds in the presence of the instructor. Cast iron is welded and tested in the same way. The testing of the work teaches the student the difference sticking pieces together and actually welding then together. The other jobs required number about forty, each with its own peculiar problem. Some of he jobs require special preparation or setting up, some require special welding or finishing, in any case the point is clearly brought out by the completion of the work. For example, a casting with a lug broken off is taken and the lug welded back on, another lug is broken off and the student required to build up a complete new lug. The student is required to write a complete report on every job completed, noting the peculiar point of each job. These reports must be written up outside of class hours. These reports must contain the amount of material used, amount of gas consumed and the time in hours spent on the job. These reports are kept in a note book together with lecture notes and reports on assigned work, so that at the end of the course the student has a very complete note book covering the entire welding field.

The men are instructed to do their work with as few tools as possible. Men are assigned work that must be done in some other part of the buildings of the institute. This requires that the entire welding equipment must be taken and set up in a place outside the shop. Particular attention is given to this assignment and the men are graded on how they handle the equipment, the completeness with which the job is started and finished, also the proper returning of the equipment.

NATIONAL CARBIDE CORPORATION

The National Carbide Corporation, Ivanhoe, Va., issues the following statement, from the office of the president:

"Our plant is at Ivanhoe, Va., on the line of the Norfolk & Western Railway. The location was selected on account of cheap hydro-electric power, pure limestone and proximity to the high grade coal and coke of the Pocahontas district. Our plans call for three electric furnaces with an estimated capacity of 15,000 tons calcium carbide per year. The crushing and screening machinery will prepare it in eight different sizes.

"The main building, 300 feet long, is of structural steel and contains nine transformers, three furnaces, two traveling cranes, jaw-crusher, disk-crushers, storage bins with sizing machinery, conveyors and elevators, packing room, machine shop and can department. Adjoining the main building is a storage room 70 feet by 200 feet, and in the rear are five lime kilns with storage bin for coal, crushers for coke and lime, coke dryer, elevators and conveyors, storage bins for coke and lime, stock yards for the raw materials, together with the necessary industrial tracks.

"The plant is built on a 20-acre tract adjoining the railroad, and it is within 1,000 feet of the New River, from which the water supply will be drawn and forced to the works by duplicate electric pumps. The main works are within two miles of the lower dam of the Appalachian Power Company, and within one mile of the limestone quarry. This contains a belt of high grade limestone within 100 feet of the railroad track. It is about 250 feet wide, with very little cover, and starts with a breast of 25 feet, increasing gradually to over 100 feet.

"The contract for designing and constructing the plant was placed with Westinghouse, Church, Kerr & Co., of New York, and, in spite of the very severe weather of the past winter and the continued rains this spring, they have made good progress. We have had less difficulty than we anticipated in obtaining machinery and supplies, and we hope to be ready for operation the latter part of July."

The officers of the company are: S. M. Buck, president; J. J. Lincoln, vice president, and H. S. Brown, secretary and treasurer. The directors are the officers and Harry Bowen, W. D. Tyler, R. E. Shirey and Herbert Markle.

Who's Who

Augustine Davis

Mr. Augustine Davis, president of the Davis-Bournonville Company, is one of the real fathers of the welding and cutting industry in the United States. He was born at Elkader, Iowa, on June 5, 1852.

A great many interesting things might be said of Mr. Davis, but nothing could be published of more interest to the fraternity than a partial copy of his remarks at the annual banquet of his company in 1916. In fact, this short address constitutes the first chapter of the early history of the welding industry in the United States. Mr. Davis said:

Augustine Davis.

"Almost ten years ago, in June, 1906, I sailed for Europe on the S. S. 'Arabic.' Landing at Queenstown, I passed through Ireland, England, Holland and Belgium, reaching Paris, France, early in July.

"At that time I was president of the International Acetylene Association, and naturally called on Mr. P. Rosemberg, who was secretary of the European association, and also Mr. R. Granjon, who was closely associated with Mr. Rosemberg in the development of the acetylene industry. I was informed by this gentleman that Mr. Eugene Bouronville, who had acquired considerable reputation an an acetylene generator inventor in the United States, was expected to arrive at Paris within a short time. I waited his arrival, and through his acquaintance with Messrs. Rosemberg, Granjon, Javal and Boas, Rodigues & Co., and other residents of Paris, I was enabled to obtain considerable information regarding the new oxy-acetylene art, which at that time was much of a secret.

"From Mr. Bournonville I learned that he had visited Paris in 1901 and had purchased from the French Dissolved Acetylene Co., for the Commercial Acetylene Co., of the United States, the process for dissolving and compressing acetylene in acetone, which has been so widely used in lighting automobiles, and more recently in connection with the oxy-acetylene process. He told me that in 1903 he had been confidently advised of the new process of 'melting metals,' by Mr. Edmond Fouche, who was connected with Mr. Picard in the employment of the Dissolved Acetylene Co., and that Mr. Fouche had a little later sent him one of the welding torches, probably the first brought to the United States. Mr. Bournonville mentioned the receipt of the torch to an employe of the City Water Works at Hollis, L. I. It so happened that one of the valves on a pump or an engine was very porous, and this gentleman asked Mr. Bournonville if the valve could be repaired by the aid of the torch. Mr. Bournonville told him that he could at least make the effort, and the valve was heated to a red heat and then sprinkled with iron chippings, and the torch being applied, the defect was remedied, and the part was still in operation at the latest date on which he had any knowledge concerning the same. This was evidently the first repair work done by use of the acetylene torch in this country.

"While in Paris with Mr. Bournonville I visited the shops of Messrs. Javal and Boas, Rodrigues & Co., and the laboratories of Messrs. Granjon & Rosemberg, and became very much interested in the process. I proposed to Mr. Bournonville that we introduce the same in the United States, and we agreed to a meeting on our return to this country. Early in September following, I met Mr. Bournonville at Hopatcong, and he agreed that as soon as I could make arrangements we would organize a company and return to France, and if possible purchase the patents for the best torches then obtainable. I went from New York to Lewiston, N. Y., where I met Mr. C. B. Wortham, who was an old acquaintance, and arranged for his service with the Davis Acetylene Co., at Elkhart, he to remain there until the proposed arrangement with Bournonville could be completed.

"Mr. Wortham and myself arrived in New York on January 28, 1907, and at once rented office space, with a second-hand desk, in a lawyer's office at 141 Broadway. On February 7, 1907, we leased an office in the West Street Building, at 90 West Street and on April 11, 1907, we moved into an office at Room 1511, 90 West Street, being, I believe, the first tenants in the building.

"On April 13, 1907, I sailed for Paris on the S. S. 'New York' with Mr. Bournonville, and on May 11, 1907, returned from Paris with Mr. Bournonville on the S. S. 'Auguste Victoria,' with oxy-acetylene welding and cutting torches together with an assignment to ourselves of the United States patents for the Gauthier-Ely positive pressure or medium pressure type of torch, which, after investigation, we had found to be more efficient than the high pressure or low pressure torches first developed. It is this type of oxy-acetylene torch which, with many of our own improvements, we have continued to manufacture up to the present time, consistently retaining, however, the original and basic principles which have proven so effective in establishing the success of the Davis-Bournonville torch. We also brought a Mr. Care, an expert welder, from France to instruct us in the process and to make demonstrations. This was the beginning of the Davis-Bournonville Co.

"May 14, 1907, three days after arriving from Paris, I

started for Elkhart to build a pressure generator which had developed in my mind on the return voyage from France.

"On May 22, 1907, tried the new pressure generator, on May 23, 1907, shipped the pressure generator to New York, and on May 30, 1907, started the new pressure generator in the shop here, and Mr. Bournonville pronounced it a decided success.

"It has always been a matter of much gratification that within about a half month's time I was able to go to Elkhart and have a generator built, and return to Jersey City and put it into successful operation, the said generator in all its essential features being the same as that which is now used with unequalled success in the generation of acetylene for the oxy-acetylene process.

"During my absence in Elkhart, Mr. Bournonville had rented the old board shanty on St. Paul Avenue, Jersey City. Owing to a disastrous explosion of compressed acetylene in Jersey City, which had been compressed in cylinders to liquefaction before the dissolved acetylene process was known, it was extremely difficult to obtain permission to install an acetylene plant anywhere within the city limits. This accounts for the out-of-the-way location and the shabby structure in which work was first undertaken.

Hans J. Mueller.

"June 13, 1907, made first public demonstration of oxy-acetylene cutting at Williamsburg Bridge. Cut an iron stringer 5 feet in width. June 15, 1907, completed first order for aluminum welding.

"June 26, 1907, Mr. Bournonville sailed for Paris on S. S. 'Teutontic' to investigate an oxygen process with a view to purchasing same. He was accompanied by Mr. Brown, an engineer for the Ferrofix Co."

Hans J. Mueller

Hans J. Mueller, vice-president and general manager of the Universal Oxygen Company, Sheboygan, Wis., has been connected with the manufacture of oxygen and hydrogen plants and the welding and cutting business, for 18 years. He was born March 3, 1882, and the first two years of his experience was secured with his father at Stockholm, Sweden, in the consulting engineering business, designing some of the first injector welding torches, with interchangeable heads, and some of the first ring jet cutting torches for oxy-acetylene as well as oxy-hydrogen. He also gave demonstrations of the process in several other countries.

Later he was connected with the Belgium and Germany Oxy-Hydric Company for two years as mechanical engineer, and later formed and built the Scandinavian Oxygen & Hydrogen Company, with which he was connected for four yeras.

He then became connected with the American Oxy-Hydric Company, of Milwaukee, Wis., for four and a half years, and erected a plant with a capacity of 10,000 cu. ft. of oxygen and 20,000 cu. ft. of hydrogen per day. At that time he gave some of the first cutting demonstrations of heavy cutting, such as

Thomas F. Stoddard.

24-inch thick armor plate, to several of the largest steel corporations in this country.

After he left the American Oxy-Hydric Company he was connected with the Oxweld Acetylene Co. for one year, and helped them built their welding shop at Chicago, where he was superintendent at that time. He then organized the Universal Oxygen Company, Sheboygan, Wis., and erected their plant. This company is manufacturing oxygen and hydrogen gases under the electrolytic cell patents, and welding and cutting apparatus. The company also has a branch in Milwaukee for distributing the products manufactured at their plant.

Mr. Mueller was born in Hamburg, Germany.

Tomas F. Stoddard

Tomas F. Stoddard, president of the General Welding & Equipment Company, has been connected for the last several years with the welding and cutting business.

In 1912 he joined the General Welding & Equipment Company, which has been formed by Dr. A. Krebs. His principal endeavor has been to line up the good trade through quality and service. He always satisfied the high class concerns and high class trade followed. In this way, he established the reputation and success of the General Welding & Equipment Company.

Since the incorporation of the company, Mr. Stoddard has been appointed president and sales manager. The treasurer of the company is Dr. A. Krebs, consulting engineer, who handles the construction end.

Mr. Stoddard was born in Chelsea, Mass., September, 1878.

P. F. Willis

Prior Fristoe Willis, president of the Henderson-Willis Welding & Cutting Company, St. Louis, Mo., was born in Howard County, Mo., on January 7, 1876.

In the spring of 1907, while employed as an engineer by a number of the old line fire insurance companies, he learned of

P. F. Willis.

a new process of welding which had its inception in France. As his work required him to constantly visit large factories, employing a great many machines, he realized that if this new process was a success only on cast-iron it would fill a long felt want. He was so impressed with its possibilities, that in November, 1907, he organized and incorporated the Henderson-Willis Welding & Cutting Company and the following year commenced the manufacture of oxy acetylene welding and cutting apparatus.

In the early days of welding, he read papers and demonstrated before technical schools, universities and various associations throughout the country, in order to educate the public to the possibilities of the art. At the Mechanics Fair held in San Francisco in 1913, and the Panama Pacific International Exposition in 1915, he maintained a "live" exhibit, demonstrating daily to hundreds who had never heard, much less seen, the oxy-acetylene flame. He was personally awarded a gold medal by the International Jury of Awards.

He has written a book on oxy-acetylene welding and cutting which in less than a year has reached its second edition.

A NEW GENERATOR

Realizing the need at the present time for an acetylene generator which is safe, simple, has no working parts and yet a constant pressure of gas at all times, the United States Welding Co. of Minneapolis, Minn., after long experimentation, introduces their new "PERFECT" generator to the welder.

These generators may be used on either high or low pressure systems. If a pressure as low as one pound is desired, or if a pressure of fifteen pounds is desired, the generator may be automatically set for the same and will remain at the desired presssure until the complete charge of carbide is used. The many washings given the gas produces results that can be equalled only by the best of cylinder acetylene, which means betters welds to the welder.

There are no working parts in the whole apparatus. No clock attachments, no springs, no weights—in fact, no friction control. This means constant pressure at all times, which is obtained by the use of a water diaphram as sensitive and accurate as the diaphrams of the very best pressure regulators. From one torch to fifty torches may be operated at the same time, depending solely on the size of the generator, without the usual fluctuation in gas pressure. No attention whatever is required except when changing water and recharging. One of the most complete and effective systems of interlocking safety devices has been manufactured and entirely prevents mistakes in operation due to carelessness by the operator in charging the generator. The generator is the most fool-proof apparatus on the market today.

All "PERFECT" generators are made to use the lump carbide, size 3½x2, which is procurable from every hardware or jobbing house throughout the country or from the carbide warehouses direct. By the use of the same size carbide in all sizes those using two generators of different sizes for different work need only buy the one carbide. Also with this size carbide there is less waste, less "dust" and more gas, with less residue, is obtained. These generators may be installed in "batteries" for large work, with but a few minor changes in pipe connections, a feature not to be overlooked.

Delivery can be made promptly on all sizes of generators from the small portable units of 26 pounds and 50 pounds capacity to the larger 100-pound and 300-pound sizes. Special generators of 500 pounds capacity may be obtained on order.

GIVE THE DETAILS

Editor:

I have in mind the fellows who have so much to say about the big jobs they do, but who fail to give details of how they went about it. Let us have *details*. The mere story of a big job is a waste of good space. Its *information* we want—something in which to build.

Nicholas E. Koch.

Editor's Comment:

Mr. Koch should have been an editor. He expressed the idea of *all* editors very well. The columns of *The Welding Engineer* should contain information of value to welders. The mere statement of a big job performed is not sufficient—*details* are needed.

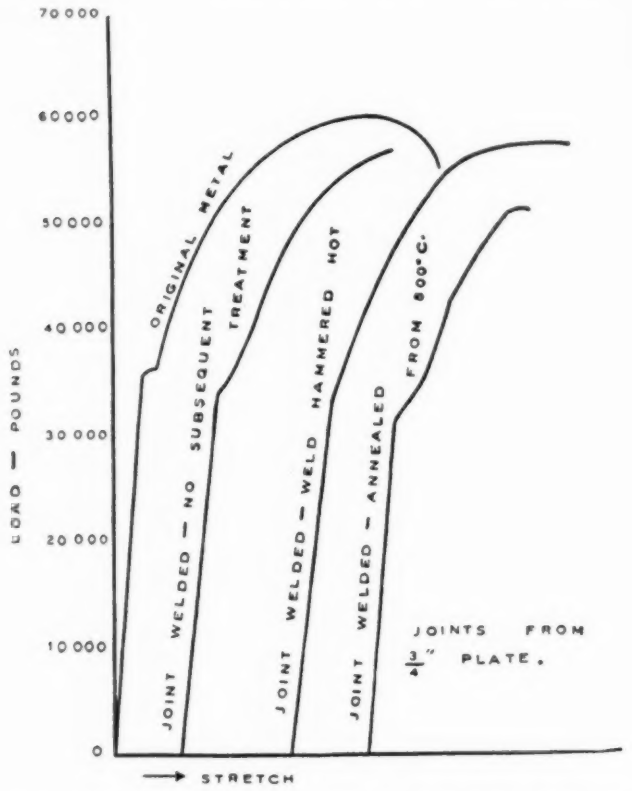
Editor.

TESTS OF OXY-ACETYLENE WELDED JOINTS IN STEEL PLATES

In view of the big increase in the use of welding processes in firebox construction, recent tests on the strength and efficiency of oxy-acetylene welded joints in steel plates conducted by the Engineering Experiment Station of the University of Illinois and published in Bulletin 98 are of interest and value. The joints were welded by skilled workmen in a plant especially equipped for oxy-acetylene welding and the results are probably a little better than could be obtained under common shop conditions.

Laboratory tests were made under three conditions of loading: (a) Static load in tension; (b) repeated loads (bending) and (c) impact in tension.

The static tension tests give an index of the resistance of the welded joints to loads applied only a few times and without heavy impact. The repeated stress tests give an indication of the resisting power of the welded joints to



loads repeatedly applied, such as loads carried by springs and axles. The impact tests give an index of the ability of the welded joints to resist sudden heavy shocks without complete rupture and high resistance to rupture under impact represents insurance against the sudden and complete failure of a part subjected to severe bending or stretching. This quality is of great importance in material for machine parts or for railway service.

The plates in which the test joints were made were steel with a carbon content of about .16 per cent and the following thicknesses of plate were used: No. 10 gage, ¼ in., ½ in., ¾ in. and 1 in. After welding, the plates were cut into test pieces and tested under the three conditions of loading as mentioned above.

Some of the comparative efficiencies are shown in the table, and the variations in yield point are shown in the chart.

A summary of the results is as follows: The tests were made on joints welded by skilled workmen and should not be considered as indicative of the strength of welds made in repair shops, or of welds made by workmen without special training in the use of the oxy-acetylene torch. For joints made with no subsequent treatment after welding, the joint efficiency for static tension was found to be about 100 per cent for plates ½-in. thick or less, and to decrease for thicker plates. For static tension tests, the efficiency of the material in the joints welded with no subsequent treatment is not greater than 75 per cent. The joints were strengthened by working the metal after welding, and were weakened by annealing at 800 deg. C.

The results of the repeated stress tests give an index of the inherent qualities of the joints and they follow in a general way the results of the static tests. For repeated stress tests the joint efficiency seems to be about 100 per cent for plates ½ in. or less in thickness, while the efficiency of the material in the joint is somewhat less. Hammering or drawing the welds while hot increases the strength and annealing from 800 deg. C. lowers it.

For static tests and for repeated stress the joint efficiency sometimes reaches 100 per cent, but the efficiency of the material in the joint is always less. This indicates the necessity of building up the weld to a thickness greater than that of the plate.

The impact tests show that oxy-acetylene welded joints are decidedly weaker under shock than is the original material; for joints welded with no subsequent treatment, the strength under impact seems to be about one-half that of the material.

If the welded joint is worked while hot, the impact resisting qualities are slightly improved, although this does not make the joint equal to the original material in impact resisting qualities. Annealing from 800 deg. C. seems to have very little effect on the impact resisting qualities.

In general the test results tend to increase confidence in the static strength and in the strength under repeated stress of carefully made oxy-acetylene welded joints in mild steel plate.

Efficiencies of Oxy-Acetylene Welded Joints in Per Cent.

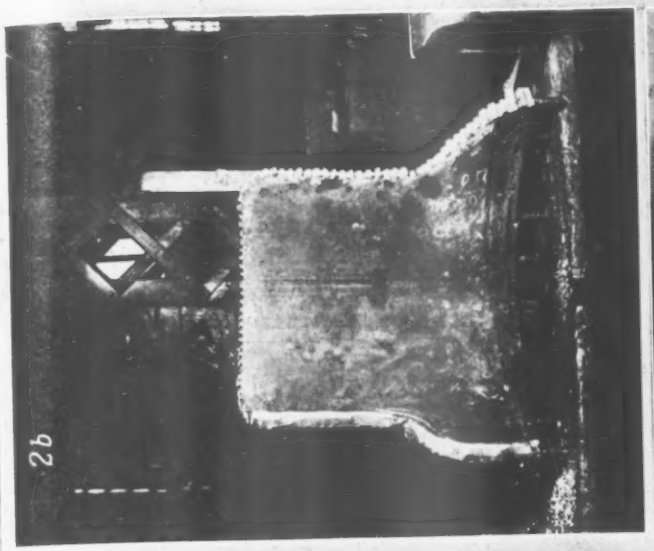
	Joint Efficiency		
	Static Stress	Repeated Stress	Impact
Thickness of plate	½ in.	½ in.	1 in.
Original material	100	100	100
Material of plate, annealed from 800° C.	89	84	89
Joint welded, no subsequent treatment	100	100	53
Joint welded, annealed from 800° C.	92	93	35
Joint welded, quenched, annealed from 800° C.	92	94	32
Joint welded, hammered while hot	101	107	58
Joint welded, hammered, annealed from 800° C.	95	102	53

—Railway Mechanical Engineer.

RECLAIMING LARGE CYLINDERS

By B. K. Smith.

The development of better methods of repairing locomotive cylinders by the oxy-acetylene welding process is being recognized almost universally as an economical and efficient operation in the railroad shop. I say recognized, but this must be qualified by the acknowledgment that in the majority of concerns who accept this as a theory, the subject of welding cylinders was only treated as superficial instead of covering the development of the oxy-acetylene process, which are based on facts, such as reliability, efficiency and economy. An encouraging feature of the situation lies in the fact that those shops with the best *mechanically* managed repairs on cylinders assisted with the electric arc process, realize that they have by no means reached the ideal homogenous repair. On the other hand, too many railroad shops are settling back into self-sufficiency after establishing a so-called *patch department*—a substitution of an ancient mechanical operation which is not reli-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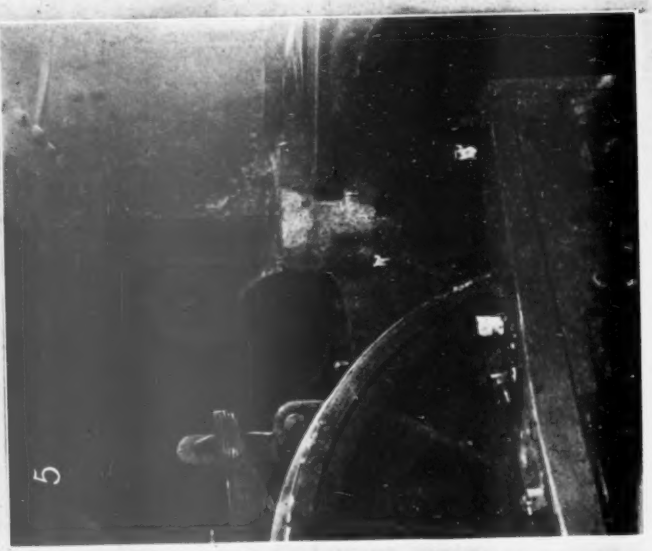
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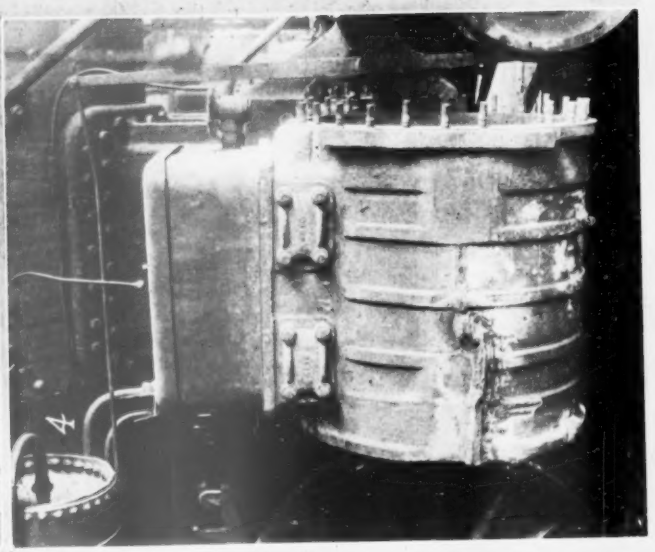
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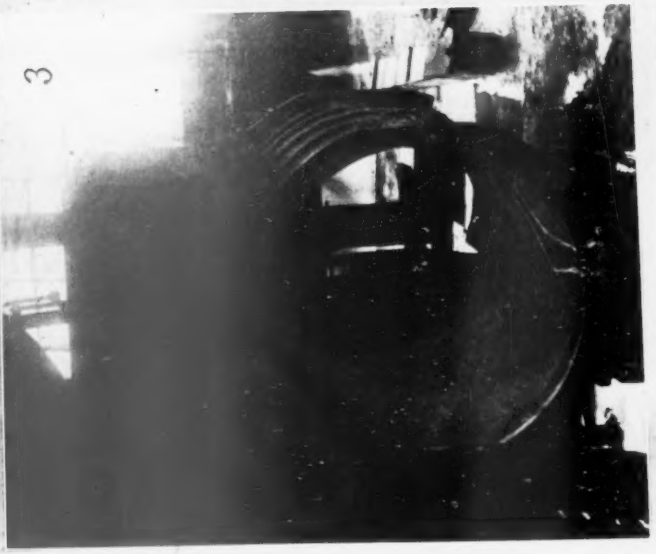
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able and which increase the cost of future maintenance, which at best indicates how time and money is lost, and not how conditions can be improved.

I have seen a large proportion of the published matter relating to the application of patches or clamps on locomotive and ship cylinders, and being covered with the electric arc they were baptized as welding operations. To impress the adaptability of these operations, the authors stated that much of that patch and covering work was performed on Government ships and locomotives successfully. In this article it is the aim of the writer to present in a few details an outline of the development of the welding of large cast iron cylinders as applied at present to about five per cent of our railroad shops with considerable success. At the same time, to make this more of a concrete illustration the writer will show a few photographs of our acetylene welded operations on cast iron locomotive cylinders.

Only a few years ago, our Technical Schools taught our students that cast iron welding was impossible because the welds could not be forged. However, with the introduction of the oxy-acetylene welding process it made the joining of cast iron or commercially called grey iron a possibility. In addition to the possibility of joining two pieces of cast iron, our early operators encountered difficulties that appeared at times insurmountable. They complained of the hardness of the welds, and the breaks on contraction. These difficulties were later avoided by using a cast iron welding rod, free from manganese or other impurities and containing a higher percentage of silicon, also a suitable cleaning flux. The effect of contraction was avoided by preheating the whole or part of the object previous to welding. Today cast iron is welded from the largest railroad shop to the smallest country blacksmith shop, but in larger operations where a little reflection is necessary and where the saving would be greater this welding method is discouraged. If one will attempt to weld a large gray iron cylinder he cannot use steel welding rods for joining the defected parts and expect to make a strong weld unless he applies a patch or brackets with the aid of patch bolts or rivets. In this case the owner invites an indefinite expense for maintaining these patches. The shocks and vibration will dislocate and oxidize the patch bolts, plates and rivets, until such time when he will have to replace the cylinder with a new one. Therefore, it is indispensable that a crack or a break in a cylinder must be thoroughly welded and should be constituted of *grey iron* so it should be capable of being machined and should be free from additional patches and rivet holes.

Figure 1 represents an Air Compressor Cylinder. The nature of the break as shown on the white line was such that it could not be patched and the owner had to employ the oxy-acetylene welding process or buy a new one and wait for it four months. The writer has welded this cylinder 8 months ago and at present it is in operation in one of the biggest power houses in the State of Michigan. The writer has published the method of welding in detail for large cylinders in the July and August issues of *The Welding Engineer*, and the only additional point that he had to take care of in this case was to support the various thin port holes and jackets from deforming or sagging.

Figure 2A represents a broken locomotive cylinder, reclaimed at a small cost (nine hours welding) with the oxy-acetylene process. The broken pieces were lost and it was necessary to cut out a new patch from an old similar cylinder that was beyond repairs (as per figure 2B). Nothing new or no special skill was required to save this cylinder, with the exception of placing and holding the patch in its proper place.

Figure 3 represents a locomotive cylinder with two long cracks welded without being removed. This cylinder was bored and bushed after welding and is practically as good as new.

Figure 4 represents a similar locomotive cylinder after welding. The broken port holes were built up and a 24 inch crack welded on the side without removing it. This cylinder has been in operation for a long time and the only trouble that it gave us was the worrying of a Master Mechanic at another point that the cylinder got hot in service. Upon his complaint we found that he based his trouble on the red brown color of the cylinder. However, after we explained that the red brown color of the burnt scale from the surface of the cylinder was obtained on account of the pre-heating, preparatory to welding, and that we did not have time to re-paint the cylinder, we did not hear any more complaints from that official.

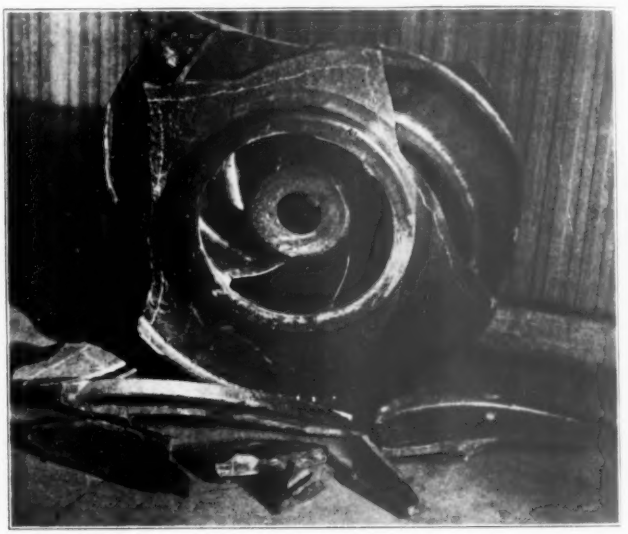
Figure 5 represents a locomotive cast steel frame that was welded in place very close to the cylinder with the oxy-acetylene process. In order to prevent the cylinder from getting too hot or crack, it was filled with water and kept cool until the welding operation was completed.

BIG PUMP JOB

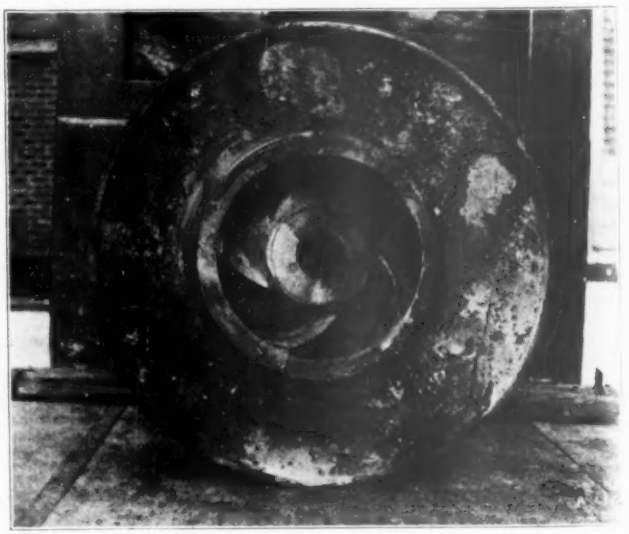
Editor:

Possibly the enclosed photographs may be of some mutual benefit to your readers, as I have had real benefit from some articles published in your paper.

The enclosed is the main working part of a large centrifugal pump. Was broken much worse than the picture shows it to be, inasmuch as the vanes all had to be rebuilt, as they were entirely broken out and lost, also to the writer's know-



Pump Before Welding.



The Finished Job.

[illegible] the chemical effect of the water in this country is very injurious to cast iron, and was very hard to weld. Forty-eight hours were consumed in putting it back in running order. A delay would have meant much discomfort to the whole population. Very near all this time was spent in welding, as we use gas for preheating and it does not take our time. This work was done with a No. 9 Vulcan tip and apparatus. We consumed 600 cu. ft. of oxygen and acetylene, a little over a can of carbide, from a Vulcan generator. It has now been running for two months and a half and shows signs of still being as good as ever.

In rebuilding the vanes we used steel pattern and ran metal in on top of it afterwards, withdrawing pattern for the next vane. The work was done by the manager himself, assisted by a boy helper who slept between times.

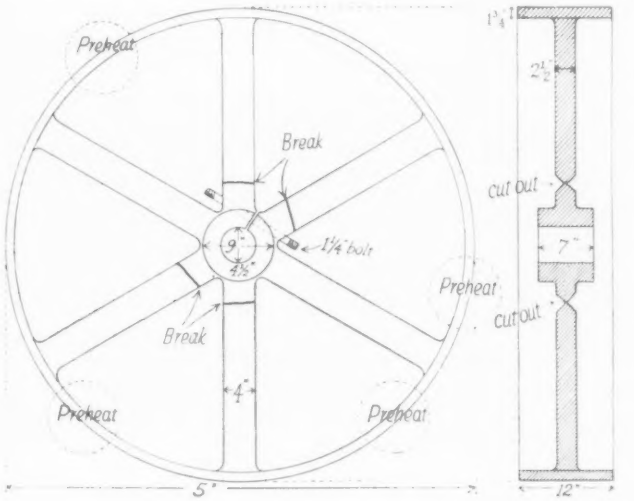
A good way to get the size is to measure it by the truck it is on when being taken to the machine shop to be trued up a little.

Hoping this may be of some mutual benefit to all parties in the welding industry, I remain,

Virginia Welding Co.,
F. Rice, Mgr.

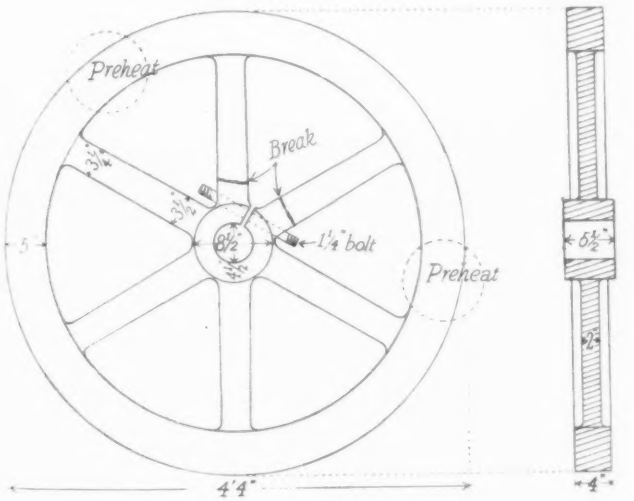
WELDING WHEELS

After welding this wheel, as shown, we found it warped. Two spokes were welded one day, two the next. The second



wheel was welded the same way, with same result. What caused it?

Joe Blackwell.



Answer: Your trouble was in preheating. Perhaps you [illegible]t rim too hot, causing crack to open up too much. Further, on left side of wheel you preheated in such a manner that one whole spoke was between two preheating points, which pulled rim out. I see no reason why second wheel gave trouble, unless you preheated to such an extent that crack opened up too much. One-eighth inch would be plenty.

Editor.

NICKLE WELDING.

Editor:

I would very much appreciate it very much if you will inform me as to the flux and material used in nickle-welding scored cast iron cylinders; also the flame used and the operation necessary to the correct fulfillment of this work, as I understand that preheating is absolutely unnecessary.

Answer: The so-called nickel-welding process of filling scored cylinders is not nickel welding at all. It is nothing more nor less than soft soldering. Sometimes instead of using soft solder a slight percentage of a harder metal is added, but the great majority of shops use the common half and half solder. It is applied to the score with a welding iron but not with a flame. No pre-heating as you can readily see is necessary. The whole secret of success in a job of this kind is getting the proper flux to enable the solder to attach itself to the castiron. We are not familiar with the details and you will find that this is a patented process. How good this patent is, of course, we are not able to determine, but we do know the owners of the patent are suing shops to stop them from using it.

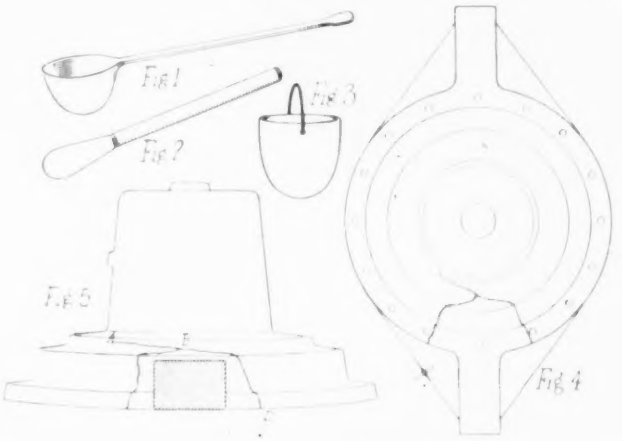
The Wilkes-Barre Welding Works, Wilkes-Barre, Pa., sell instructions for doing the work for $10.00.

The owners of the process are L. Lawrence & Co., Newark, N. J., and Chicago, Ill.

WELDING A DODGE TRANSMISSION CASE.

Editor:

I have learned a new method of welding aluminum which can be applied to any kind of aluminum castings with great success. First of all, the broken parts must be put in alinement just the same as any other job for welding. This Dodge case was held together by a ⅛-inch welding wire run through



both support legs and twisted tight as in Figure 4. The case was put on a charcoal fire and preheated. Aluminum welding rods were put in a cast iron melting pot and put on a forge and melted so that the metal flowed freely. Then a small ladle was also put on a charcoal fire to be kept warm. When the case was sufficiently heated a No. 8 D. B. torch was used with a puddling rod (Fig. 2), to V out the crack and clean off all oxide that might form. Then a ladle of hot metal was placed in a convenient place and with the puddling rod the molten metal was taken from the ladle and puddled into the V. At the same time the torch was used to keep the heat. The weld was started (Fig. 5) at A to B,

(Continued on Page 44.)

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VOLUME 3. JUNE, 1918 NUMBER 6.

Our Lines Of Defense

EVERY nation has three lines of defense. They may be called Wisdom, Might and Money! When Wisdom has failed, through diplomatic means, to settle a difficulty with another country the relations with that country are broken off, and resource is had to the second line of defense—Might, the Might of the manhood of the nation. This resource of the nation, however, willing or patriotic, cannot make a single move without the support of the third line—Money. To wage war on the modern scale, enormous sums of money must be raised by any first-class nation engaged in the conflict.

War is a great test of character. This nation is being tested now. We failed in our Wisdom. Our diplomacy which was exercised for the purpose of keeping us out of the Great World War failed of its object. It failed because of the unscrupulous character of the enemy. But we have not failed in our second line of defense. Already we have an army in France, and 1,500,000 of our bravest and best earnestly training for what lies before them, and anxious to be there. We have not failed in our manhood.

The question now is, are we going to fail in our third line of defense—Money? We have not failed so far. The largest single loan ever put out by this nation before the present war was $198,000,000 for the Spanish-American War. And now we have successfully put through three Liberty Loans—the first of $2,000,000,000 and the second of $3,800,000,000, while a third loan of $3,000,000,000 has just been oversubscribed by $1,166,000,000.

Early Estimates As To War's Duration

When this war was started financiers were generally of the opinion that it could not be waged on the modern scale for more than six months, or possibly a year. But here we are, in the fourth year of the war, and there seems to be no sign of it coming to an end from financial exhaustion.

Welding Schools

IN the past three months a considerable number of welding schools have been established. This is good for the industry and we wish these schools well. We believe, however, in organized attact—organized effort. So far as the industrial situation is concerned, and the prosperity of the welding industry is affected, the more schools of welding the better. But so far as the needs of the United States Army and Navy are considered it is our opinion that our efforts to meet the existing situation should be made to co-ordinate.

In this issue we are asked to announce the need of welders for two purposes—building ships, to assist in keeping our boys at the front supplied with necessities—and building Liberty motors—the eyes of the army.

It would appear that we ought to organize to train and supply welders for every purpose, industrial, army and navy needs.

Tip Sizes

QUITE frequently we are asked by a reader if a certain sized tip is suitable for a given piece of work. It's quite impossible to answer inquiries of this kind, for the reason that there is a great difference in tip sizes. For instance, a number eight tip, as manufactured by one manufacturer, will not correspond to a number eight tip as marketed by another manufacturer. Drill sizes are also changed frequently, with there being a corresponding change in tip number.

It would seem that manufacturers of welding and cutting torches should establish some standard, so that tips may be identified by the drill size.

The Second Class Rate

ON July first publishers of magazines and trade papers will be required to pay second class postage on the basis of the new Zone system. This means that it's going to cost about fifty cents per year to mail *The Welding Engineer* to California.

Just why a welder in California should be harder to reach, with valuable information than a welder in Illinois, is not quite clear. Of course, somebody will have to pay the freight and as the publishing business has already suffered, the question is, who's going to be the goat?

We want more readers and we don't want to lessen our chances of securing them by increasing the cost of *The Welding Engineer*. Readers of trade papers should register a strong protest at Washington.

CAST IRON BOILERS.

Editor: I have poor success with cast iron boilers. Please give me your advice. H. B.

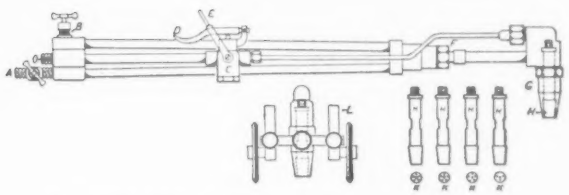
Answer. From your description of the failure I have no doubt that it was not properly preheated and the reason the stays broke between the shells was on account of a too rapid cooling.

Cast iron boilers are difficult to weld and require intelligent manipulation, particularly in preheating and cooling. In your case it was not necessary to preheat the whole section, but just the bottom adjoining the crack has to be preheated to redness. Great care should be taken in supporting the lighter portions of the boiler from sagging. For this class of work it is necessary to preheat with charcoal about 4 inches deep and helped with an oil or coal gas burner. But the heating should be performed slowly with the charcoal alone, when the casting is pretty hot, then apply burner to get it red. After welding, all holes and crevices must be covered with fire clay and left to cool slowly.

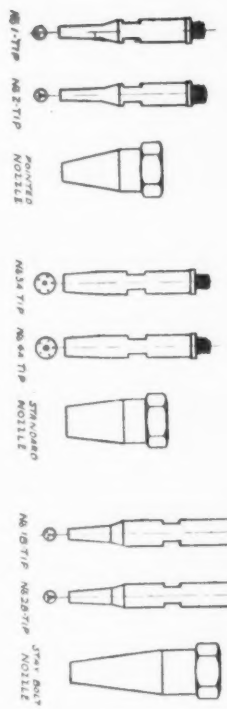
In case some of the lugs or stays are broken, it is practical to replace them with threaded stay bolts, nuts and ferules on each end. Editor.

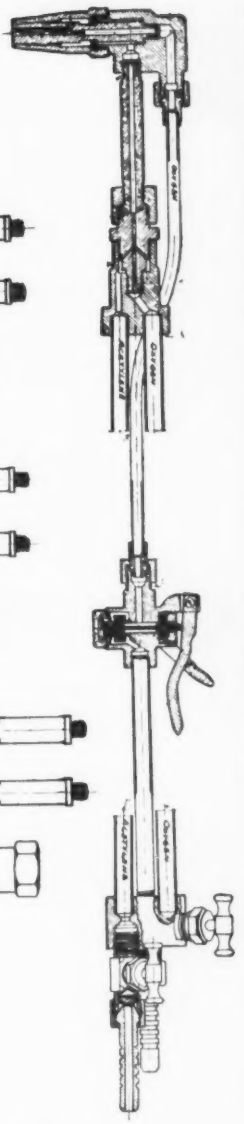
GENERAL WELDING & EQUIPMENT CO.
G.W.&E.CO.
107 MASS. AVE. BOSTON, MASS.

STANDARD CUTTING TORCH



O, Oxygen Inlet; A, Acetylene Inlet; B, Oxygen Valve; C, Lever Key; D, Lever; E, Lock; F, Mixing Chamber; G, Copper Nozzle; H, Cutting Tip; K, Tip End.





THEIR RECORD:

MANY THOUSANDS of these CUTTING TORCHES are in daily use all over the United States and Canada, a greater part being repeat orders from concerns having used these cutters for a number of years. They work in shipyards, arsenals, steel foundries and other important concerns.

THEIR PRINCIPAL FEATURES:

Our Cutters are second to none in efficiency, economy and endurance. They are so constructed that

ALL PARTS OF THE CUTTING TORCH ARE EASILY ACCESSIBLE AND EXCHANGEABLE AND CAN BE REPAIRED IN A FEW MINUTES BY YOUR OWN MAN.

With carrying a few spare parts, a burnt and even smashed up cutter can be fixed up like new in less than half an hour. No cutter need come back to our factory to be repaired. You can do it yourselves and avoid the delay of a week or two.

THEIR CONSTRUCTION:

The sketch shows cross section of the principal parts. Three tubes come up from the base, one carrying acetylene or hydrogen, the other two oxygen,, one for preheating and one connected with a lever key for cutting.

The preheating gases mix in a special mixing chamber. To this mixing chamber, the head is screwed on by means of a ground joint swivel and loose nut coupling. The swivel is brazed in the head of the torch to make a tight fit even under heat.

The oxygen cutting by-pass is screwed onto the head with a ground joint swivel and nut and in the same manner to the lever key or trigger valve. Thus the head or the by-pass can be removed or exchanged in no time. The mixing chamber can easily be taken out and cleaned. The lever key is accessible from all sides and the seat can be replaced in a minute or two.

(Continued from page 41)

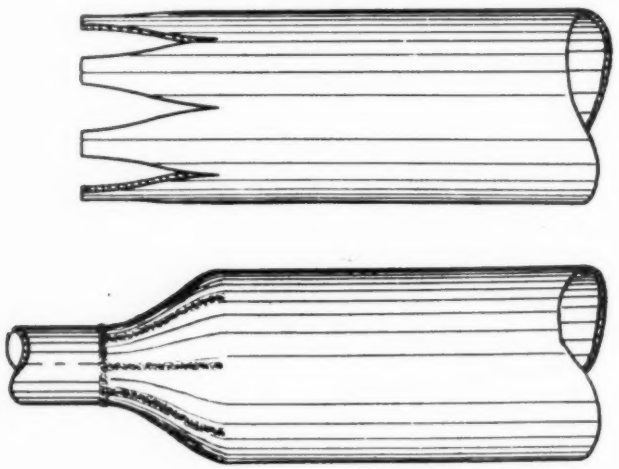
and from B down left hand crack. I then cleaned off on the inside and finished weld from B to D, turned case over and finished off on inside. Now this kind of welding makes a very neat and strong weld, relieving the weld of all possible chance of having oxide in the weld, as would be the case in a narrow stick weld. By melting the metal in a melting pot (Fig. 3) all of the oxide will float to the top and can be skimmed off, leaving nothing but the very best metal. With a little practice on the welder's part he will be able to make a satisfactory weld and there is not a doubt in my mind, but that he will adopt this method. As to the time, this case was welded in five minutes, but it is advisable to have a number of jobs in readiness and weld them all at once.

Take a crank case, for instance, that has a hole knocked in from a connecting rod. A piece of thin copper sheet metal could be clamped on the inside and then the case preheated. After the edges are cleaned off the metal can be put in and welded, leaving a very nice job without going to the trouble and expense of having a casting made.

Mathew Kauffmann,
M. R. S. Unit 306, Q. M. C.,
Bk's 443 Colgate, Md.

WELDED SWEDGE NIPPLE

This wrinkle consists of a piece of scrap pipe, any desired length, which has been cut to the shape of an orange peel with the points of the lips cut off to fit any size pipe



wished. After which, it is heated in a forge and the lips are bent into the size pipe desired to swedge to and welded together with the oxy-acteylene process.—John Fink, in *Natural Gas.*

CRIPPLED SOLDIERS TO LEARN WELDING.

In a discussion of the organization, work and method of the Red Cross Institute for Crippled and Disabled Men, just completed by its director, Dr. Douglas C. McMurtrie, stress is laid upon the necessity of reform in the public attitude toward the cripple if "reconstruction" work for the maimed, both of military and industrial armies, is to be carried on successfully in this country. At the same time Dr. McMurtie reports encouraging success of the young institution, thus far, and prophesies that the work it is doing will prove of immense value when the military authorities find themselves confronted with the problem of rehabilitation on a large scale.

The institute was established in 1917, and is a national activity of the American Red Cross, with headquarters at 311 Fourth Avenue, this city. It is responsible to the War Council through Jesse H. Jones, Director General of Military Relief. Supervision of operation is under a committee composed of

One of the principal parts of the institution is the educational department wherein an occupation is selected under these considerations: Its suitability for handicapped persons, the length of time required for training, the standard of wages in the industry, the prospects of employment, and the attitude of the trade towards apprentices. Four trades already have been decided upon and equipment installed for teaching them. They are the manufacture of artificial limbs, oxy-acetylene welding, mechanical drafting and printing. The manufacture of artificial limbs has been found especially suitable, while there is a great shortage of skilled workers in this trade. At the same time men themselves maimed are found to display sympathetic interest in and understanding of the problems to be solved.

There is a Field Work Department, which gets in touch with cripples and interests them in the opportunities for assistance offered them. There has been held a series of "parties" for cripples, and these affairs, at which men, themselves badly handicapped, tell how they have made new successes of their lives. The institute maintains an employment department, which is doing painstaking, effective work in searching out openings for cripples and broadening the field of receptivity.

MANUFACTURING A STEEL CHAIR

By G. F. Wetzel, Production Engineer, Frank S. Betz Co., Hammond, Ind.

Recently a number of steel ward chairs for use in Government hospitals were manufactured, the allotment herein described numbering twelve hundred. The making of these chairs involved some methods which might be applied in the manufacture of other articles, and furnishes a good example of the benefit of both the acetylene and electric welding processes in the manufacture of steel furniture.

The chair consists of the tube or outside diameter, one continuous piece forming the back and back legs; two back strips form a six-pointed star. Each group took one stroke of the punch press; the center one being stamped out first, and the sheet rotated on a pin to get each of the circles of perforations. In making the seat it required three operations: (1) Cut into squares from sheet, (2) cut into circular form, (3) perforate.

The back straps required no other work to prepare them for the assembly than cutting to length, and straightening a few pieces.

All the joints in the chair were made by the acetylene-welding process except that between seat ring and sheet, there being twelve acetylene welds. To enable the welders to set the work up rapidly a jig was made, which held the legs, back, brace ring, and seat ring in their proper relative positions. One welder would tack (or weld just enough to hold) each joint, remove the work from the jig, and pass it on to another man to finish the weld. In this way only one jig was necessary for the desired output, and one man doing all the setting up enabled him to become very proficient. The next step was to spot-weld the seat in place. The most efficient way would have been to spot-weld the seat sheet to the ring as the first step in the assembly, but the heat from the following acetylene welds would have caused the sheet iron to buckle.

The seat was attached with a spot-weld about every 1½ in. around the circumference. The four following operations were necessary: (1) Set up in jig, (2) tack all joints except on seat sheet, (3) finish weld, (4) spot-weld seat.

Since even the best acetylene welder can not make a weld smooth enough to enamel over without being finished, there was considerable filing to be done.—*American Machinist.*

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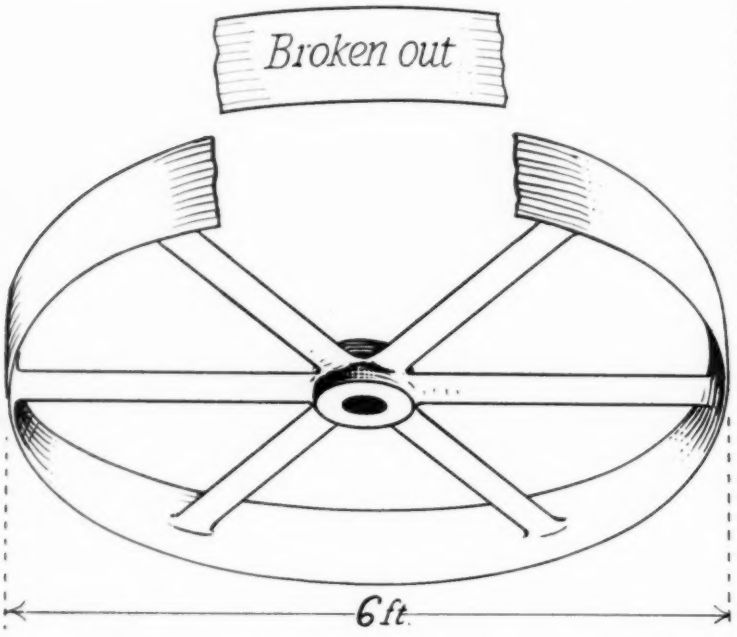
Smith Inventions, Incorporated

Dept. 1 **Minneapolis, Minn.**

CAST IRON PULLEY.

Editor:

This wheel had shrunk together ¼ inch. We used screw jacks, as per your advice, expanding wheel in order to fit broken part in place. After clamping piece into place we wrapped asbestos around face of pulley on both sides of crack. We



did this to localize heat to vicinity of weld. We used a Hauck No. 7 torch on the job. Time, six hours.

Charleston Welding Works.

VERTICAL AND OVERHEAD WELDING BY THE OXY-ACETYLENE PROCESS

By S. W. Miller*

Recently, the statement was made that the electric-arc metallic electrode was the only means by which vertical and overhead welding could be done. But every experienced oxy-acetylene welder knows that both vertical and overhead oxy-acetylene welding are being done in hundreds of shops and that much work could not be done if such welding were impossible by this process. The oxy-acetylene process is used for repairing locomotive firebox sheets—welding cracks and applying patches—yet the work on the side and flue sheets and back heads, as well as the work of welding the flues to the flue sheets, is entirely on vertical surfaces. Man shops apply new side sheets by this process when overhead welding is necessary in the case of radial stay construction, while almost all automobile frame breakages have at least part of the weld thus made. However, overhead welding should not be resorted to unless necessary. It is more usual to weld steel in these ways than other metals; but a really expert welder is able to handle cast iron, brass, and aluminum. In the case of heavy castings much handling of hot casings can be avoided if the operator is able to weld vertically and overhead.

The feasibility of this work depends on the surface tensions of the metal and the slag on its surface; the temperature range of partial solidification of alloys on cooling from the liquid state, which may be called their freezing range; the fact that pure metals solidify instantly as soon as the proper temperature is reached, so that they have no freezing range; and the heat-conducting power of the metal. That liquids have a surface tension is easily seen by drawing a needle between the fingers to give it a slight coating of oil, and then laying it carefully on the surface of the water in a dish. Not only will the needle float, but its weight will depress the surface of the water so that the needle will lie in a hollow. It will be found that quite a little force is needed to make the needle break through the water surface, although when it does it at once sinks to the bottom. This supporting property is possessed, to some degree, by all liquids, including molten metals and it is for this reason that all liquids form into round globules when in small quantities. All pure metals, on cooling from the melted state, solidify instantly as soon as their freezing temperature is reached; alloys, however, solidify gradually through a range of temperature. Thus pure iron solidifies at 2,730 degrees F., while steel containing 1 per cent of carbon, which is an alloy of carbon and iron, begins to solidify at about 2,600 degrees F. but is not entirely solid until 2,175 degrees F. If one end of a cast-iron rod and one end of a copper rod of the same diameter and length are heated in a fire, the other end of the copper rod will become hot much sooner than will the other end of the iron rod, because copper is a better conductor of heat than cast iron. It is clear then that more heat will be required to weld a copper piece than a cast-iron one of the same size, because, while their melting points are not very different, the conducting power of the copper is much higher and the heat is taken from the weld faster.

Everyone who has tried knows that it is much harder to weld vertically and overhead than in the usual way and that overhead work is the harder of the two. The difficulty also increases as the fluidity of the molten metal; that is, steel is the easiest to weld, then come aluminum, cast iron, and brass. A comparison of the factors that affect the welding of cast iron and steel is shown in the accompanying table. While the effect of these factors is not equal, the comparison shows that steel is the easier to weld overhead.

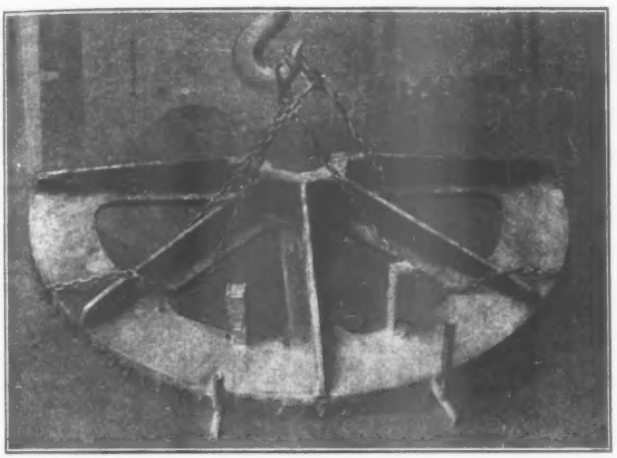
When a small area of steel is melted, the good heat conductivity of the metal tends to prevent this melted area from becoming too great; so the high surface tension acting on a small amount of molten metal tends to prevent its running away, which tendency is increased by the rapid solidification. The surface tension of the slag has but little effect, because its melting point is lower than that of steel.

When a small area of cast iron is melted, the poor heat conductivity tends to hold the heat in the vicinity of the melted part, which with the large range of solidification, makes it hard to keep the molten metal in place. The slag has a higher melting point than the metal, and its high surface tension helps to keep the metal from running away. Any welder knows that if he uses flux on overhead cast-iron welding, he cannot keep the metal in place because the flux makes a slag melting at a low temperature and exposes the metal. If too much metal is melted, its weight will exceed the surface tension of the metal and it will drop away. The blast from the torch and the breaking of the slag film with the welding rod also increase the trouble. On the other hand, the great solidification range makes it unnecessary to heat cast iron to so high a temperature, in the same way that a plumber succeeds in wiping a solder joint. If it were not for the pasty condition of the solder, which is due to part of the alloy being melted while the rest is not, such a joint could not be readily made. If the metal to be welded is preheated until very hot, a smaller torch tip and less blast will be required, a smaller area of metal will be melted, and there will be less weight to break down the surface tension of the slag and metal.

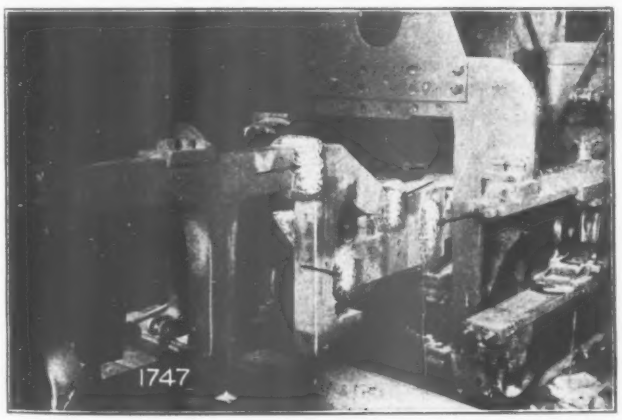
In the case of cast aluminum, the range of solidification of the usual aluminum-copper alloys is large and the surface tension of the oxide (slag) covering of the melted metal is very great. Every welder of this material knows that the oxide film is so strong and persistent that it has to be broken with a puddling rod in order to get the metal to

*Rochester Welding Works.

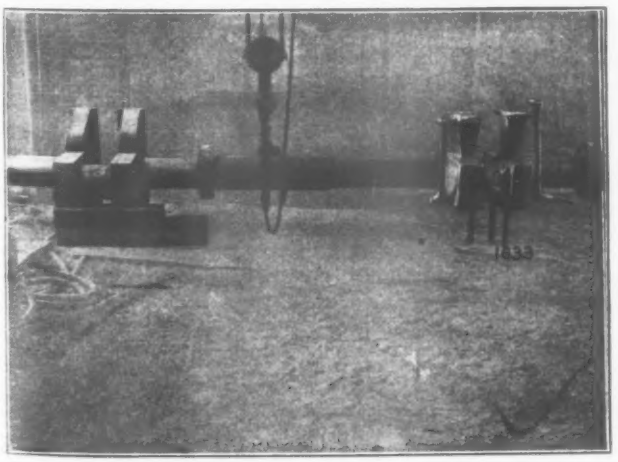
New neck cast on to large roll made with the aid of Thermit and having the pods cast in at the same time.



Large bevel gear on which two new teeth and crack have been repaired.



Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.



New crank pin welded in by the Thermit Process.

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Remember that Thermit should not be confused with either oxy-acetylene or electric welding. It stands in a class by itself. It welds sections which cannot be successfully welded by any other method.

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* * * *

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unite; also its heat conductivity is high, so that in the writer's opinion, it is the easiest metal, aside from steel, to weld overhead.

Overhead Welding Qualities of Cast Iron and Steel

Factors Affecting Welding	Steel	Cast Iron	Effect on Overhead Welding of Steel	Effect on Overhead Welding of Cast Iron
Surface tension of metal	High	Low	Good	Bad
Surface tension of slag	Low	High	Bad	Good
Range of solidification	Small	Great	Good	Good and Bad
Heat conductivity	Good	Bad	Good	Bad

Machinery

The overhead welding of brass (the term brass here includes all metals having copper as a base) depends so much on the composition of the alloy that it is not possible to say much about the subject. As a general rule, it is a difficult matter, although with a proper welding rod and proper handling a fairly good job may frequently be made. The quality of the welding rod has probably more to do with the successful welding of these alloys than in the case of any other metal, although some of the alloys cannot be successfully welded even when the weld is on top, let alone overhead.

Cutters at Work in a Ship Yard.

The usual good welding methods and ordinary welding materials do not permit of as good results in overhead welding as in ordinary work. Usually, good welding practice requires a large pool of molten metal, so that the slag can rise to the surface, the use of proper fluxes in the case of cast iron and brass, and of a welding rod of lower melting point than the original material: all of these are opposed to the conditions of overhead work. The best results can be obtained by thoroughly preheating the parts, using no larger a tip than is necessary, avoiding the use of flux, keeping as small a pool of molten metal as possible, keeping the metal as far from the upper part of the solidifying ra as is consistent with a good union, (that is keeping it n a partly pasty condition), and keeping the welding rod the molten metal. To meet these conditions requires great kill,

Many Uses Are Found for the Torch in Building Our Merchant Marine.

which can only be acquired by experience.—Reprinted from *Machinery* for April.

RECONSTRUCTING CRIPPLED SOLDIERS

We must count on the return from the front of thousands of crippled soldiers. We must plan to give them on their return the best possible chance for the future.

Dependence cannot be placed on monetary compensation in the form of a pension, for in the past the pension system has proved a distinct failure in so far as constructive ends are involved. The pension has never been enough to support in decency the average disabled soldier, but it has been just large enough to act as an incentive to idleness and semi-dependence on relatives or friends.

The only compensation of real value for physical disability is rehabilitation for self-support. Make a man again capable of earning his own living and the chief burden of his handicap drops away. Occupation is, further, the only means for making him happy and contented.

Soon after the outbreak of hostilities the European countries began the establishment of vocational training schools for the rehabilitation of disabled soldiers. They had both the humanitarian aim of restoring crippled men to the greatest possible degree and the economic aim of sparing the community the burden of unproductivity on the part of thousands of its best citizens. The movement had its inception with Mayor Edouard Herriot of the city of Lyons, France, who found it difficult to reconcile the desperate need for labor in the factories and munition works while men who had lost an arm or a leg but were otherwise strong and well were idling their time in the public squares. He therefore induced the municipal council to open an industrial school for war cripples which has proved the example and inspiration for hundreds of similar schools since founded throughout France, Italy, Germany, Great Britain and Canada.

The disability of some crippled soldiers is no bar to returning to their former trade, but the injuries of many disqualify them from pursuing again their past occupation. The school

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of training prepare these men for some work in which their physical handicap will not materially interfere with their production.

The education of the adult is made up largely of his working experience. The ground work of training in his past occupation must under no circumstances be abandoned. The new trade must be related to the former one or be, perhaps, an extension or specialization of it. For example, a man who has done manual work in the building trades may by instruction in architectural drafting and the interpretation of plans be fitted for a foreman's job, in which the lack of an arm would not prove of serious handicap. A trainman who had lost a leg might wisely be prepared as a telegrapher, so that he could go back to railroad work, with the practice of which he is already familiar.

Whatever training is given must be thorough, for an adult cannot be sent out to employment on the same basis as a boy apprentice. He must be adequately prepared for the work he is to undertake.

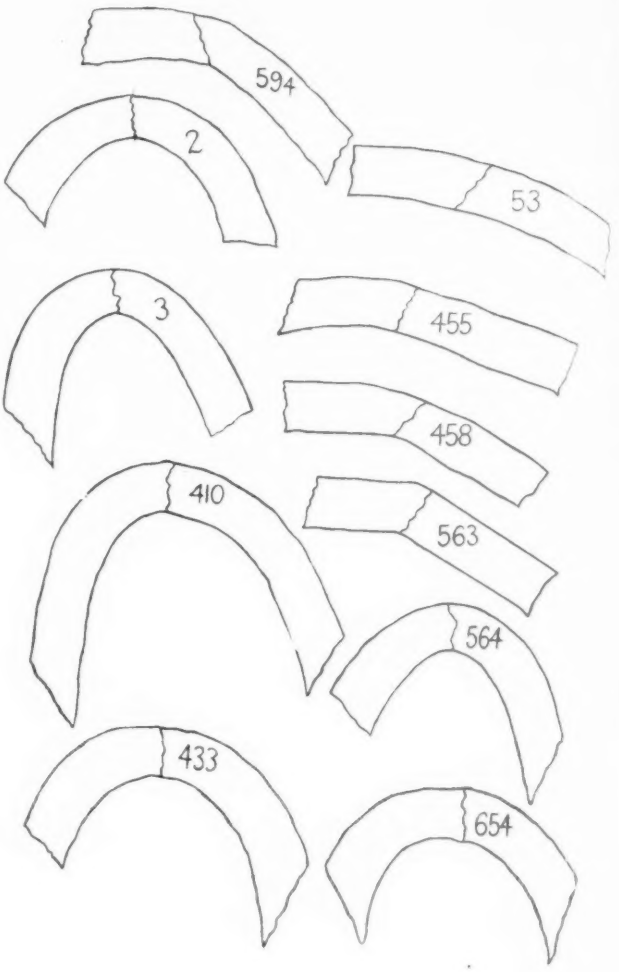
TEST DEPARTMENT.

The third installment of test welds, submitted to *The Welding Engineer* under the plans announced in the November, 1917, issue, have been inspected, with the results shown in the accompanying table and illustrations.

For the benefit of those readers who have but recently become subscribers, it might be of interest to state that for the sake of uniformity all test pieces were furnished, on application, by *The Welding Engineer*. The pieces consisted of two pieces of ½x2 inch tank steel, beveled and ready for welding. Under the terms of the trial the welds were made from one side, were not annealed, and were reinforced not more than 1/16 inch, and not ground.

Of the eighteen pieces reported in the January issue, but one test piece fully measured up to the requirements.

The first thing done was to examine the specimens carefully with a small magnifying glass, and the general appearance is



Specimen.	Torch.	Size Tip.	Size and Kind of Ware.	Width of Weld.	Through at Bottom of V.	BEND TEST BLOWS. To Crack.	BEND TEST BLOWS. To Break.	BEND TEST BLOWS. To Break on Reverse.	Appearance of Fracture.	Remarks.
2	Henderson Willis	7	¼"	1⅞"	Yes	....	34 n.b.	1	Broke along one side of V half way up.	One lap ⅛"x½" in center of weld. Small amount of oxide in top of weld.
3	Picard No. 1	750	1/16" Norway	1⅜"	No	15	26	....	Top of weld 3/16" deep oxidized and full of gas pockets.	Weld not thorough for ⅜", ⅞" long not thorough for ⅛" deep.
53	Vulcan No. 2	6	¼"	1¼"	No	6	7	....	Neither end of V molded for ½" on each side.	Weld full of laps and holes.
410	Carbic	10	¼" Armco	1⅜"	No	17	28 n.b.	1	Looks porus and oxidized.	Not thorough in spots.
433	H. W.	7	¼"	1⅜"	Not all	....	27 n.b.	1	Top 1/16" of weld oxidized. Many small laps.	Some small laps in top of weld.
455	Vulcan No. 2	6	¼"	1¼"	Yes	12	13	....	Full of laps. Broke loose on one side of V. Cracked at other Edge.	Edges of V not filled in flush.
458	.....	....	¼"	1⅜"	Except ½"	4	6	....	Full of laps—one half of weld all laps.	Not welded thorough. Several bad laps in weld.
563	Oxweld	8	3/16"	1⅜"	No	3	7	....	Top of weld oxidized for ⅛" deep. One edge of V not welded.	
564	Oxweld	10	¼"	1⅜"	No	15	25	....	Top half of weld all laps.	
594	.....	....	1/16" Norway	1¼"	All but ¼ in.	8	12	....	Top 1/16" of weld oxidized in places.	Some small laps and one ⅛" and ⅜" in weld.
654	Wareham	8	¼"	1¼"		....	32 n.b.	1		

*N. b. means notbroken

described in the table. The piece was next ground off to the same thickness as the original metal and clamped to an anvil with the bottom of the weld at the edge of the anvil, and bent over by successive blows of a twelve-pound sledge. Care was taken to round the edges at the point of bending to about 1/16-inch radius to avoid starting a crack at the sharp edge. A number of specimens broke under this treatment before they had reached a right angle bend. Others stood the bending until the sides were parallel, and the amount of such bending is indicated on the sketch attached. Such as did not break under this test were reversed, and, in every case they broke at the first blow.

An examination of the fracture was carefully made to notice any defects that might exist, and in all cases where the weld was noticeably defective nothing further was done, the idea being that it is useless to make any further tests of a weld not sound. The idea is that what is wanted to determine is how

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to make a sound weld, and if the welders are to obtain good results this is the first thing they must strive for. After they are successful in this direction further examination should be made of the qualities of the weld which cannot be determined by the examination of the fracture with a hand glass.

In the cases where the welds appeared clean and sound the examination was carried further by polishing and etching a section and examining it under the microscope. In some cases this disclosed imperfections that should not exist and which detract from the strength of the weld.

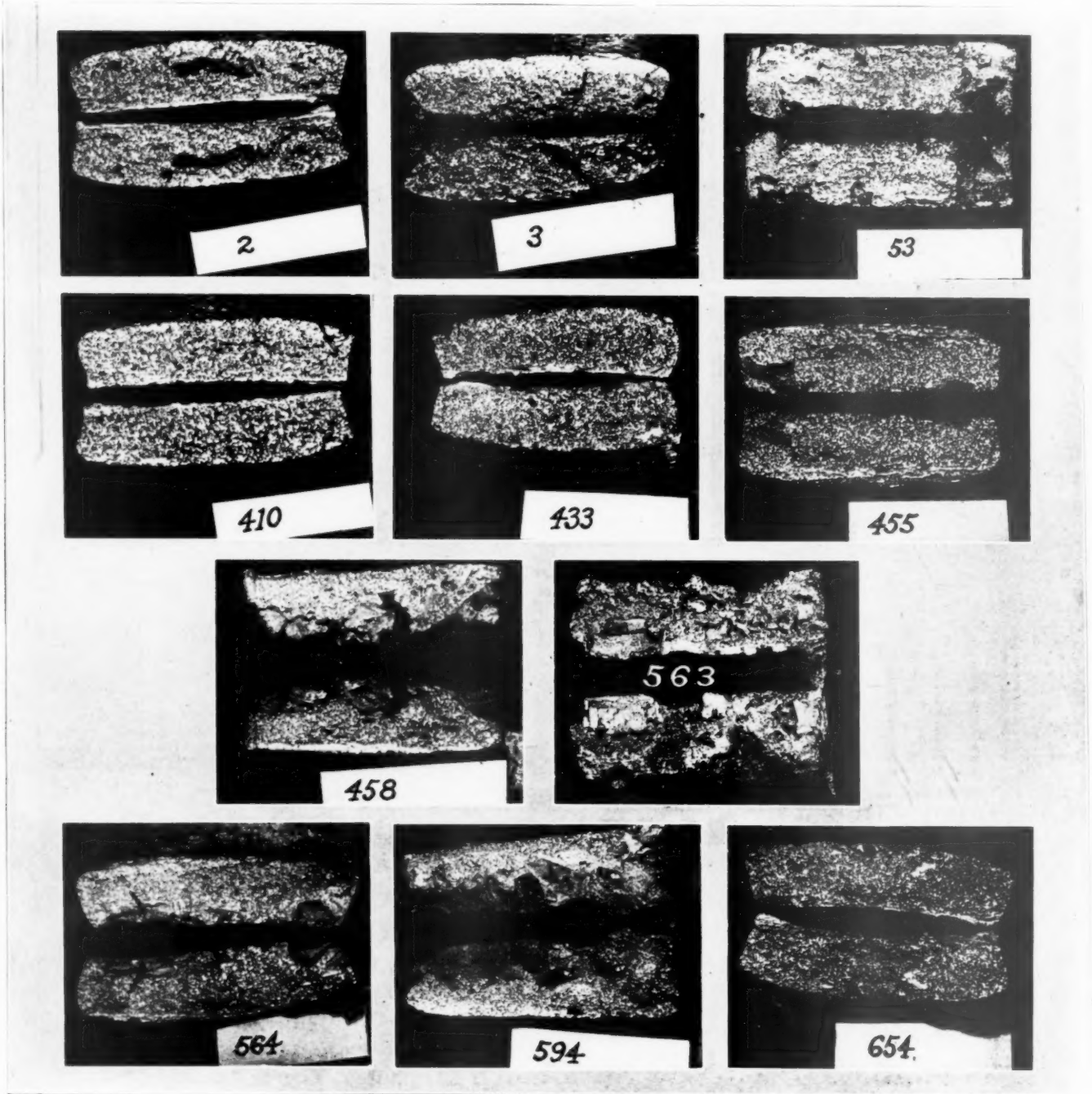
WELDED SHIPS

An eastern newspaper prints the following relative to some experiments that are being made:

Admiral Bowles is keenly intent on testing the merits of electric welding in shipbuilding, and has determined to make an extensive experiment of it at Hog Island.

At his instance the American International has ordered the immediate construction by the General Electric Company of four machines of a type which will embody the ideas of two different inventors. The principle is that of spot welding as opposed to arc welding, and is not the Wilson idea, which was utilized in repairing some of the interned German ships. In spot welding the plates of the hull, for instance, overlap the same as they do in riveting, whereas in the Wilson method the plates are welded edge to edge. The latter has not yet won the approval of the shipbuilding authorities.

Great advances have already been made in the introduction of arc welding for caulking and cutting and for uniting the thinner steel plates. It was found some months ago that the British yards were far ahead of the American yards in this respect.



Result of Tests. See Table on Page 52.

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"Weld-a-cast" is a scientific combination of chemicals that causes the metal to melt rapidly, shortening the operation thus economizing in time, gas and oxygen.

"Weld-a-cast" adheres readily to the hot welding rod, which picks up just enough and none is wasted; it does not blow away but melts at once; it eliminates blow holes and leaves the metal soft.

Write For Free Samples

CORTLAND WELDING COMPOUND CO.
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At the request of the Emergency Fleet Corporation the British Admiralty sent an expert and an operator to help it introduce the system on this side, and they have given demonstrations at various shipyards and to the skilled men who have been receiving instruction in shipbuilding pedagogy at the industrial training centers. In consequence, the utilization of arc electric welding is becoming common.

Spot welding is conceded to be still in the experimental stage, but it will be given a thorough try-out at Hog Island, both on the ships and in the fabrication shop. Tests with the apparatus provided by one of the inventors have been in progress for some time at the yard of the Federal Shipbuilding Company at Newark.

There is much reason to believe that it will prove a decided success. It appears that a steel gondola car was built with spot welding as long ago as 1911 and is still giving excellent service.

MATTHEW M. LAWLER

Matthew M. Lawler, vice-president and general sales manager of the United States Gauge Company, is dead. He was one of the pioneers of the welding industry and was well known and respected by the entire industry.

He was born in Brooklyn, N. Y., on January 20, 1871. Educated at St. Peter's Parochial School, Brooklyn. Upon finishing school he became identified with the shipping department of Schaeffer & Budenberg, manufacturers of gauges, and finally became a salesman for that company.

Later he accepted an offer from the J. L. Mott Iron Works, becoming identified with their heating department, he having charge of the installation of their hot water system.

He was the organizer of the Standard Gauge Company, of which he became vice-president—and later, organized the United States Gauge Company, of which, at the time of his death, he was vice-president and general sales manager. The factory was established at Sellersville, Pa.

His home was at No. 21 Clarkson Avenue, Brooklyn, N. Y., from which his funeral took place on the afternoon of May 3rd, thence to Holy Cross Roman Catholic Church, interment being in Holy Cross Cemetery.

He was a member of the Bensonhurst Yacht Club, and is survived by a daughter, Catherine Dorothy Lawler; a son, Matthew M. Lawler; three brothers, William D., John A. and Edward C. Lawler, and a sister, Miss Josephine Lawler.

NEWS.

Announcement is made of the marriage of Lieutenant Lorn Campbell, Jr., to Miss Dorothy Randall, on May 29, 1918. Lieutenant Campbell is in charge of the Army Welding School, at Peoria.

The Torchweld Equipment Co., Chicago, are preparing to enlarge their manufacturing facilities, to provide for a business which is growing very rapidly.

The Electrolytic Oxy-Hydrogen Laboratories, 15 William Street, New York, have issued a new Bulletin "G.," relating to oxygen and hydrogen generators. A copy will be sent on request.

A school of oxy-acetylene welding has been opened by the Polytechnic High School, Long Beach, Cal. Mr. R. C. Wilson, 902 Coronado Avenue, is in charge.

B. Kopperchmidt, who has changed his name to B. K. Smith, is now with the U. S. Welding Co., Minneapolis.

The Alexander-Milburn Co., Baltimore, Md., have issued a new catalog (No. 24) which describes and illustrates a line of portable acetylene lights for use at night or in places where artificial illumination is required. In addition to the various lights, several types of torches and generating plants are described. A number of views of the lights in use, together with complete instruction for their operation, are included.

The Davis-Bournonville Co., have opened an office at Minneapolis, Minn., with J. N. Harkins in charge. A complete line of equipment and supplies are carried. Among recent large orders was one from the Aviation Mechanics Training School, St. Paul.

The Stevens Institute of Technology, Castle Point, Hoboken, N. J., has opened a school of welding. Mr. A. S. Kinsey is in charge.

DUNHAM'S NEW TORCH

The Bastian-Blessing Co., of Chicago, who for years have marketed the well known "Rego" regulators, are announcing elsewhere in this issue a new line of welding and cutting apparatus, designed by M. Keith Dunham. Mr Dunham needs no introduction to the trade, his book, "Automobile Welding" and his articles in many technical papers having brought him before the entire trade. His wide experience and knowledge of the trade, coupled with the strength of the B-B organization and manufacturing facilities, assures the success of the new line.

Classified Ads

Help Wanted—25c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—50c per line, minimum 4 lines.
Count 8 words to line. Add 6 words for keyed address.

Wanted—Salesman to solicit subscriptions to *The Welding Engineer*, or furnish names of possible readers. Compensation good. Correspondence confidential. Write Mackenzie.

Position Wanted—Experienced oxy-acetylene welder wants position as foreman; all-around experience. Address J. D. care this paper. 1-t-June

Cast Iron Welder Wanted—Experienced operator, capable of handling work for Indiana foundry. Must understand jobbing work, which we secure to keep him busy. No students. Give experience and wages expected. Address Indiana, care this paper. 1-t-June

Wanted—One copy of *The Welding Engineer* for December, 1917, to complete our library files. The New York Public Library, New York, N. Y. 1-t-June

For a Soldier in France—Wanted, one copy of Grayjohn & Rosemberg's book on welding. Price, $2.80. Mackenzie, care *The Welding Engineer*.

Wanted—Man thoroughly familiar with all the details of welding to further the sales of welding rods, wire and supplies on commission basis. W. S. Wilson Corporation, 155 Chambers street New York. 1-t-June

Like A Flywheel—

The stabilizer of the Lincoln Arc Welder steadies your arc, as a flywheel steadies an engine.

It is not a resistance—it wastes no power — it keeps your arc under perfect control — IT MAKES BETTER WELDS.

There are so many more reasons why you should use a Lincoln Arc Welder that we have prepared a 48-page book about them.

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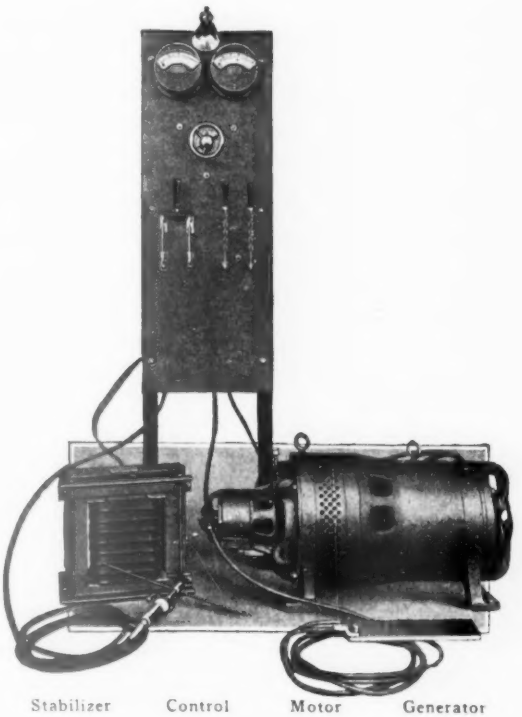

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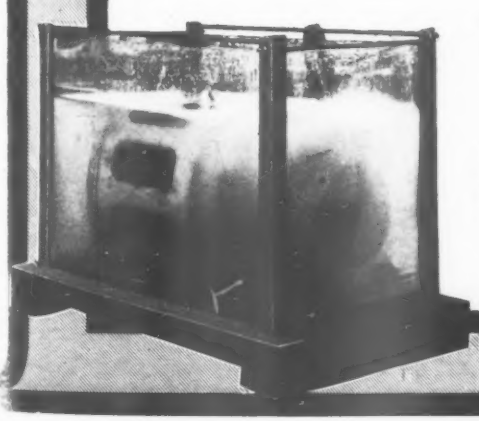
Write for Booklet No. 104-L.



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And Your Torch Backfiring Every Two Minutes.
Heavy Jobs A————

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Hold on! What were you doing just then? Storing away that interesting bit of welding experience, or a photograph, perhaps? Don't do it? Give it to us. We want to show it to 4,099 other readers of The Welding Engineer (you're the forty-one hundredth). If there are objectionable features to it, just leave it to the Editor (he studied surgery), cutting off and adding to is his hobby.

Another thing, when you work out a successful solution to a welding problem write us about it. Grammar and composition don't count—it's ideas we want. If a sketch would illustrate your job in good shape, just make a rough pencil sketch; our draughtsman will do the rest.

If the welding industry is to grow, you welders must pass along your experiences. We pay for them.

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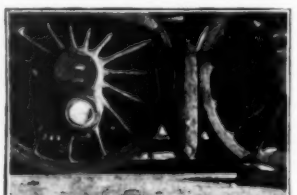
Two Days Shop Work Done In Twenty Minutes

By use of an Imperial Outfit, the broken rod pin on the Monon engine drive wheel, pictured below, was repaired in twenty minutes. The expense and delay of sending the engine to the shop was eliminated! In piercing a hole through 7¼ inches of metal there was no back fire whatever from the cutting torch of the



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167 Pages **Price $1.00** ***Fully Illustrated***

This is the only complete book on the "Why" and "How" of Welding

Explains in a simple manner apparatus to be used, its care, and how to construct necessary shop equipment. Proceeds then to the actual welding of all automobile parts, in a manner understandable by everyone.

Gives principles never to be forgotten. Aluminum, cast iron, steel, copper, brass, bronze and malleable iron are fully treated, as well as a clear explanation of the proper manner to burn the carbon out of the combustion head.

Automobile Owners, Garage and Service Stations, Blacksmiths and Machine Shops, as well as industries using the oxy-acetylene flame, will find this book of the utmost value, since the perplexing problems arising when metal is heated to a melting point are fully explained and the proper methods to overcome them shown.

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CHAPTER II.—SHOP EQUIPMENT AND INITIAL PROCEDURE.
Preheating Agencies—Welding Table—Location of Welding Outfit—Starting the Welding Outfit—Adjustment of Flame—Principle of Welding—General Welding Knowledge—Welding Rods and Fluxes—Choice of Tip—Expansion and Contraction.

CHAPTER III.—CAST IRON.
Simple Welding—How to Hold the Flame—Hard Cast Iron—Pin Holes and Blow Holes—Lug on Cylinder—Water Outlet—Cylinder Welding—Compression Head—Finishing and Testing—Scored Cylinders—Cylinder Parts—Fly Wheels—Pistons—Crank Cases — Babbitted Bearings — Valve Guides—Preserving Threads—Conclusion of Cast Iron.

CHAPTER IV.—ALUMINUM.
Use of—Welding Knowledge—Puddle System—Flux System—Comparison of Systems—Welding Rod—Preparation of the Weld—Inlet Manifold—Arm of Crank Case—Welding the Arm Without Taking Out the Motor—Break in the Body of Case—Welding Cold —Wrong Method of Setting Up—Lug or Boss Welding—Preheating the Case —Gas Preheating Flame—One Side or Both—Collapse of Weld—Broken Bearings—Direction of Welding—Shrinkage Cracks—Missing Parts—Finishing—Die Moulded Castings—Body—Other Parts.

CHAPTER V.—STEEL.
Welding Knowledge—What the Flame Does to Steel—The Welding Rod—Simple Welding—Position of Flame—Reinforcing the Weld—Frame Welding—Lengthening the Chassis—Tube Housings—Worn Parts—Gear Welding — Case Hardening — Light Metal Welding—Gasoline Tank—Welding Adjacent to Rivets—Shaft Welding—Construction of Parts.

CHAPTER VI.—MALLEABLE IRON, COPPER, BRASS, BRONZE.
How to Detect Malleable Iron—Brazing Malleable Iron—Rear Housing—Reinforcing the Braze—Brazing Tube to Housing—Building Up Worn Parts—Copper—Brass and Bronze—Silver Soldering.

CHAPTER VII.—CARBON BURNING AND OTHER USES OF OXYGEN AND ACETYLENE.
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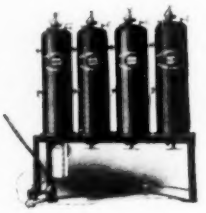

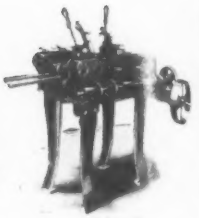

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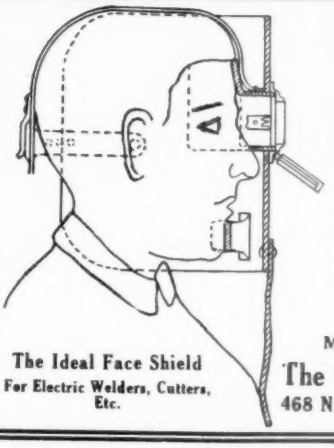

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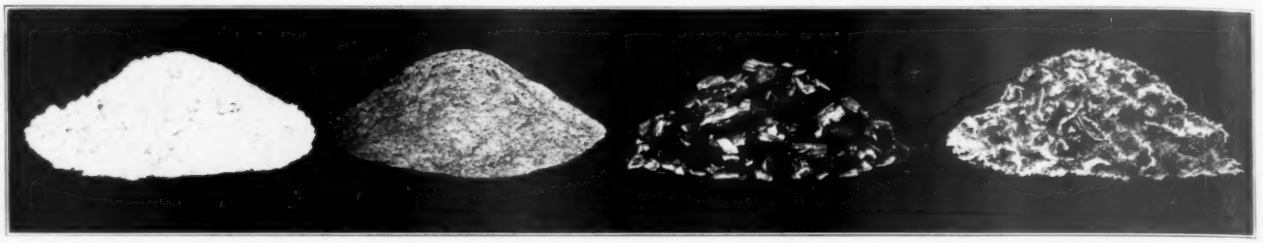

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